FIG. 1A

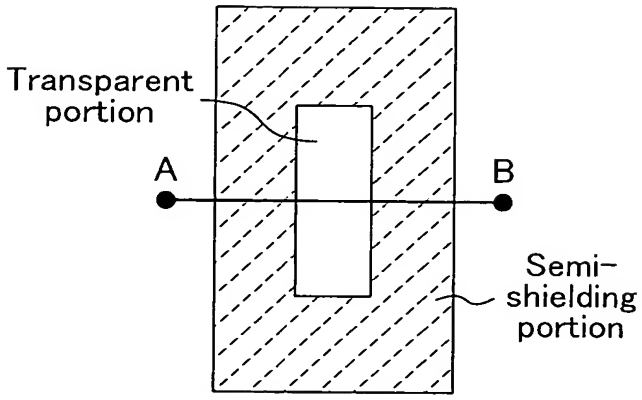


FIG. 1B

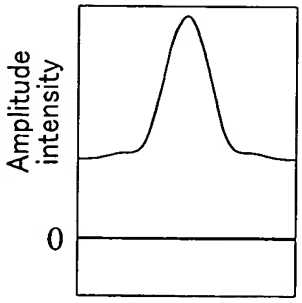


FIG. 1C

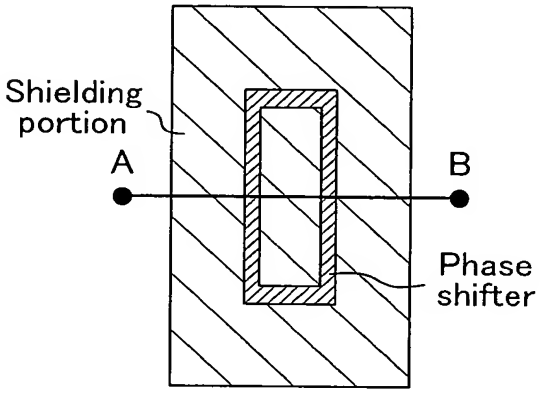


FIG. 1D

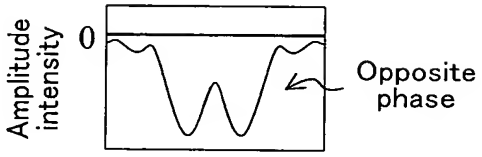


FIG. 1E

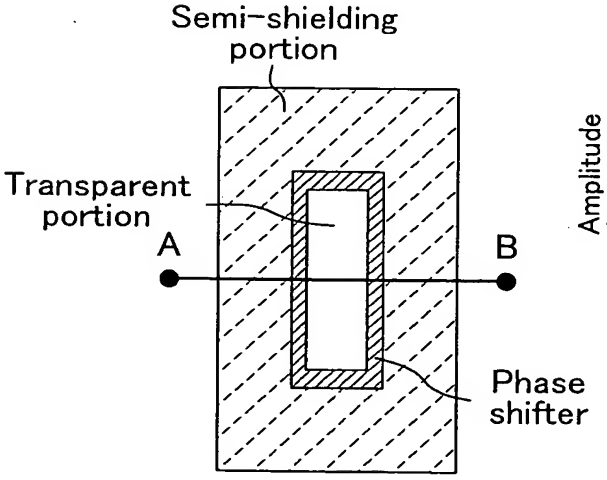


FIG. 1F

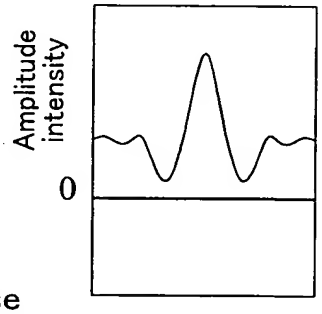


FIG. 1G

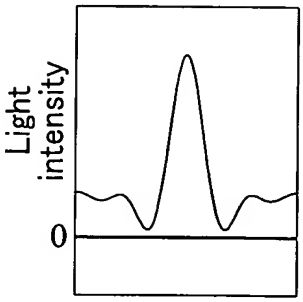


FIG. 2A

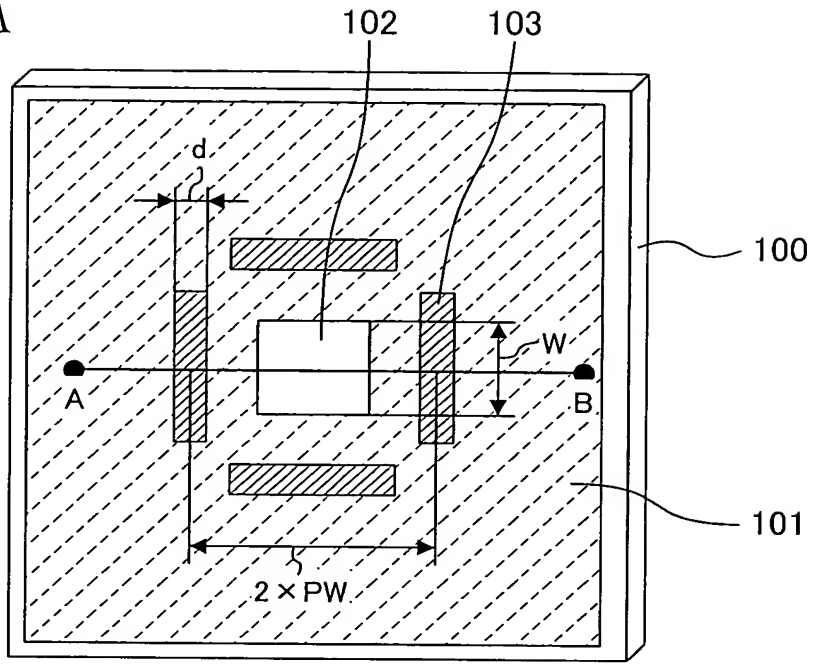


FIG. 2B

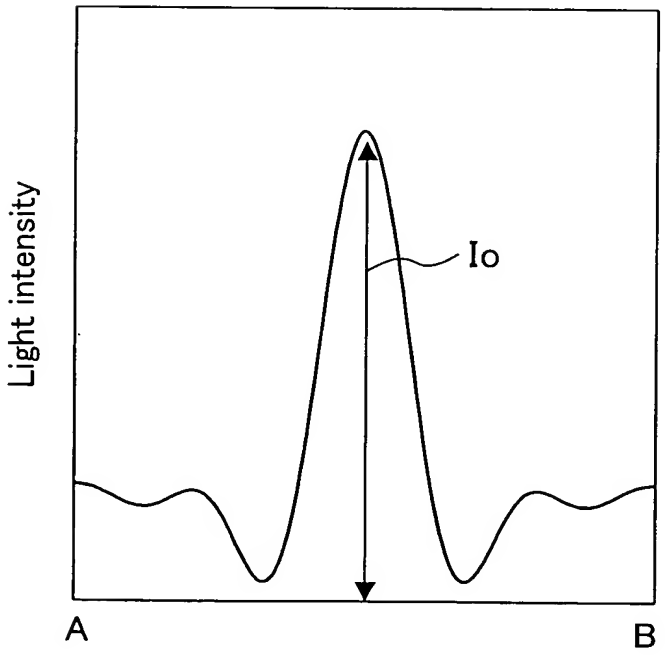


FIG. 3A

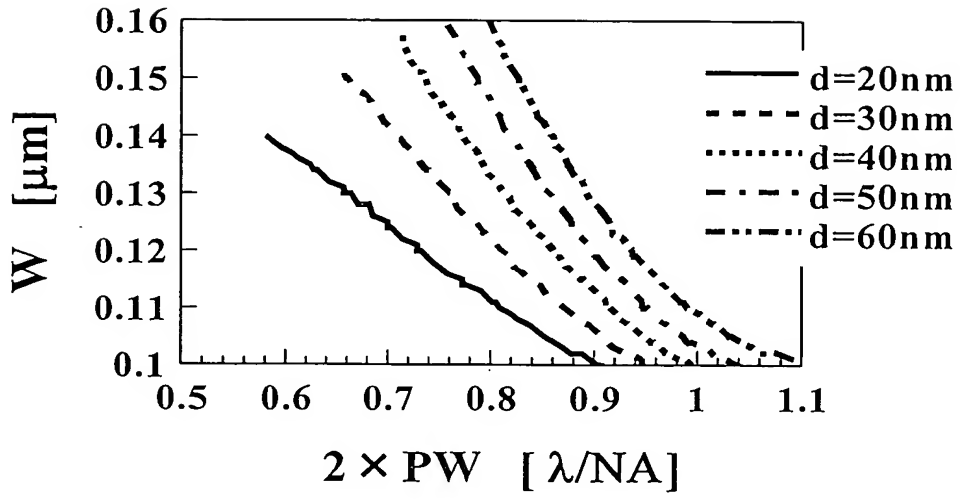


FIG. 3B

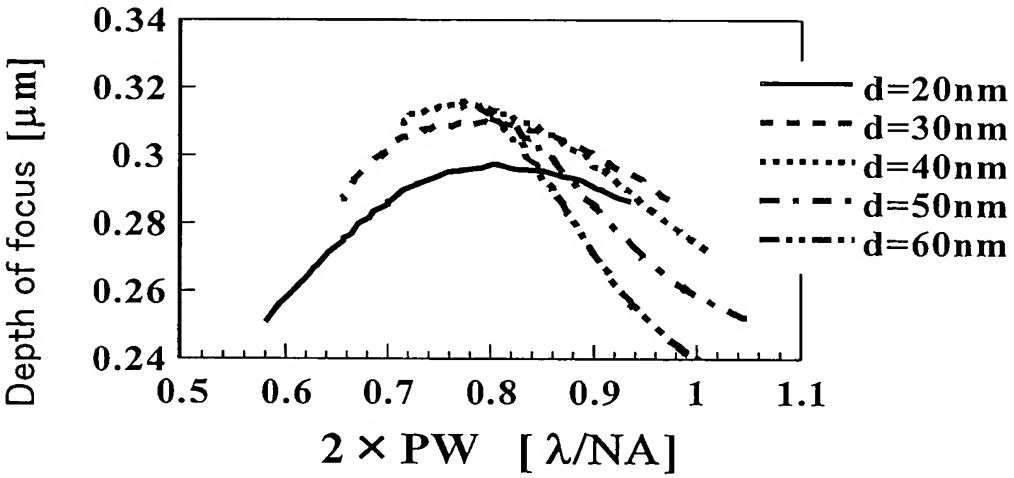


FIG. 3C

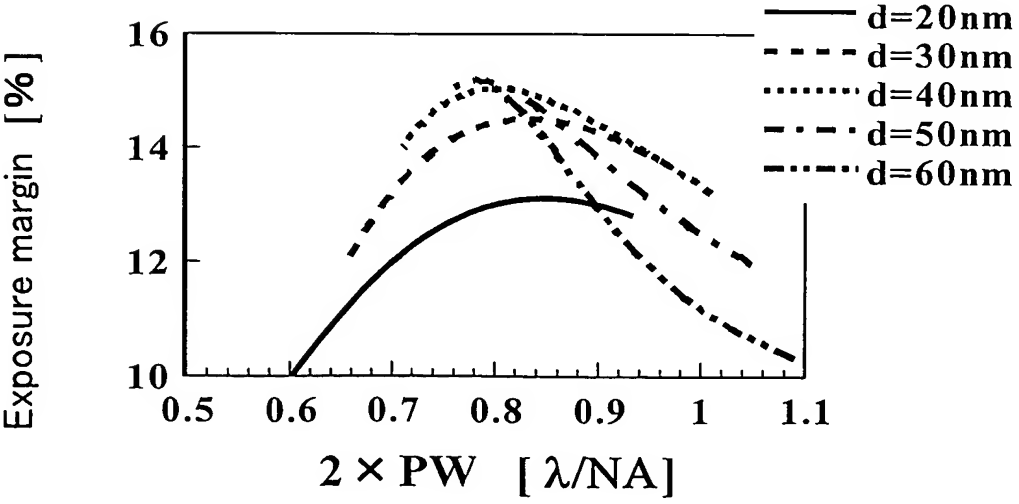


FIG. 4A

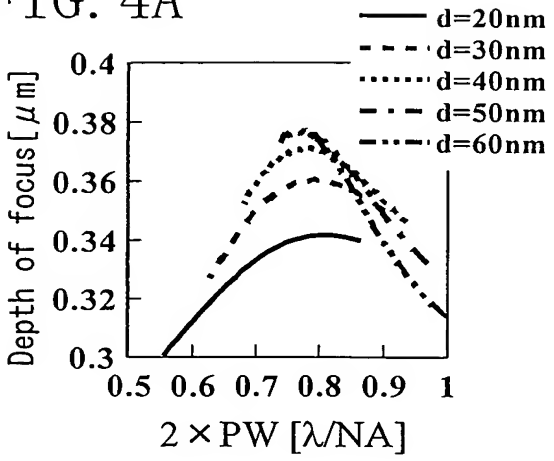


FIG. 4B

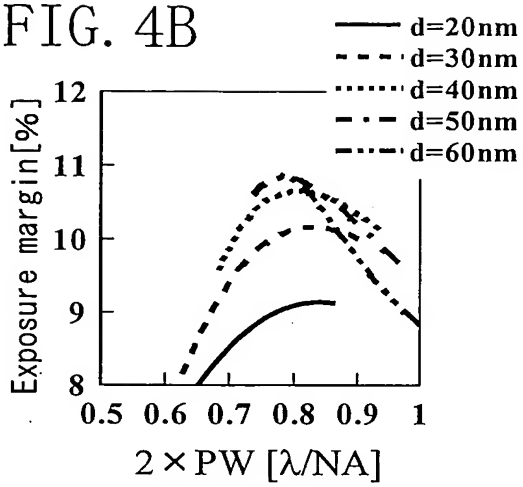


FIG. 4C

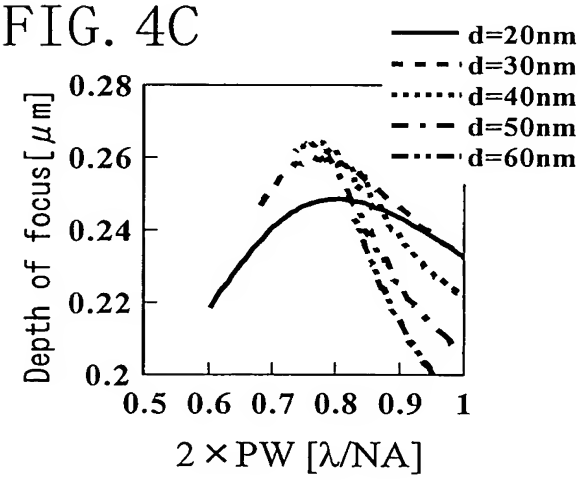


FIG. 4D

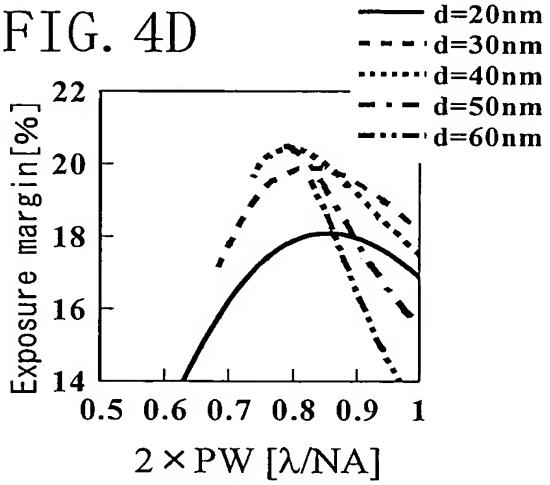


FIG. 4E

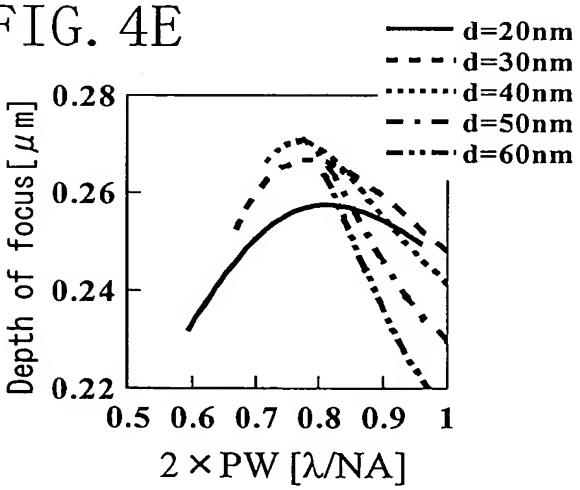


FIG. 4F

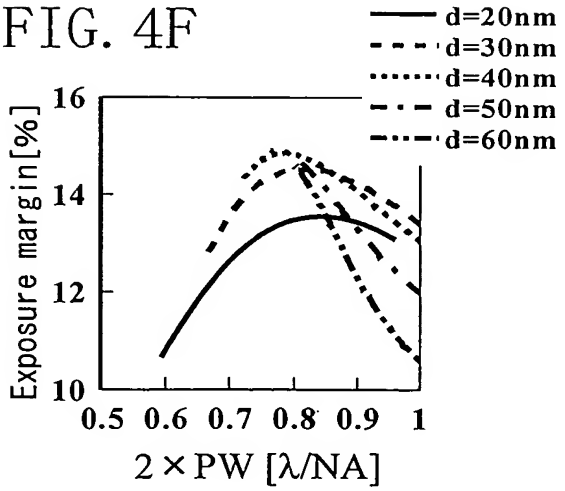


FIG. 5A

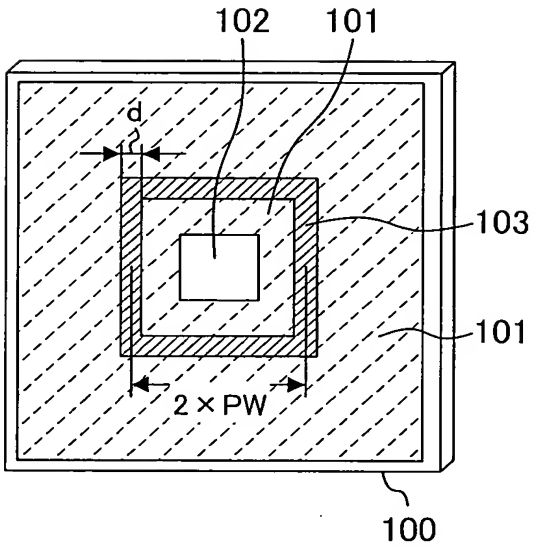


FIG. 5B

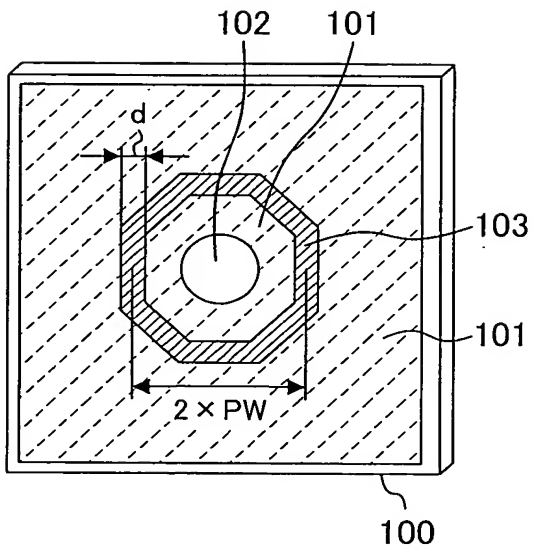


FIG. 5C

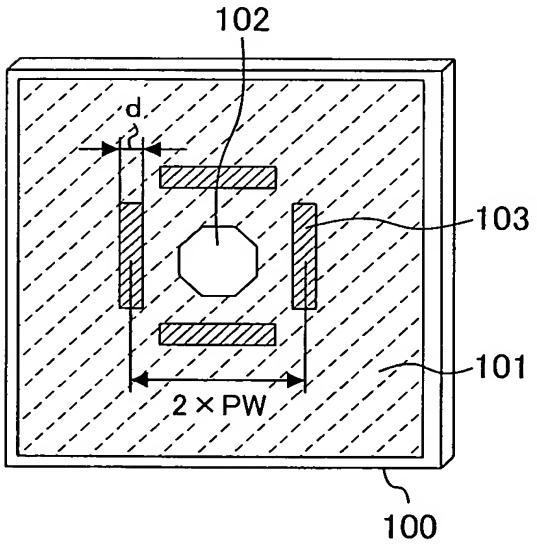


FIG. 5D

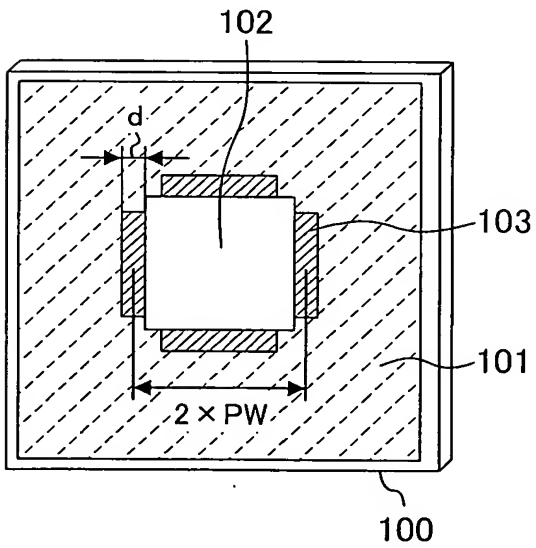


FIG. 6A

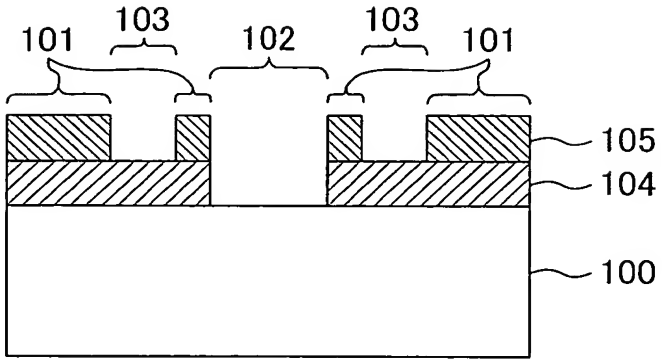


FIG. 6B

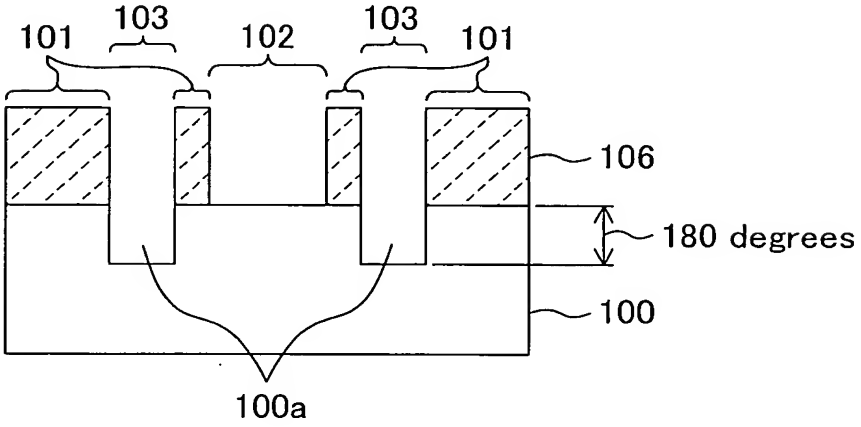


FIG. 6C

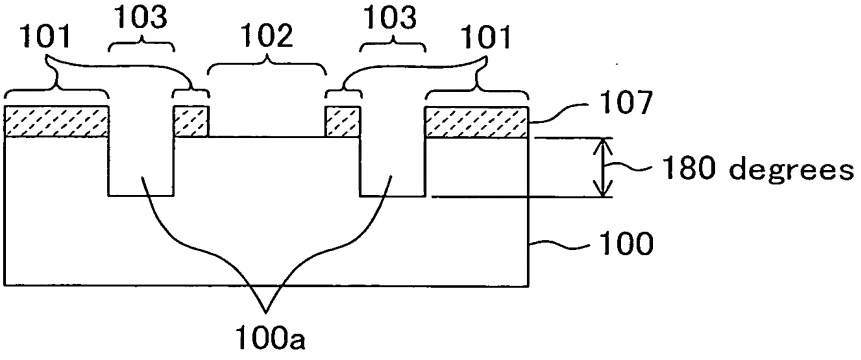


FIG. 6D

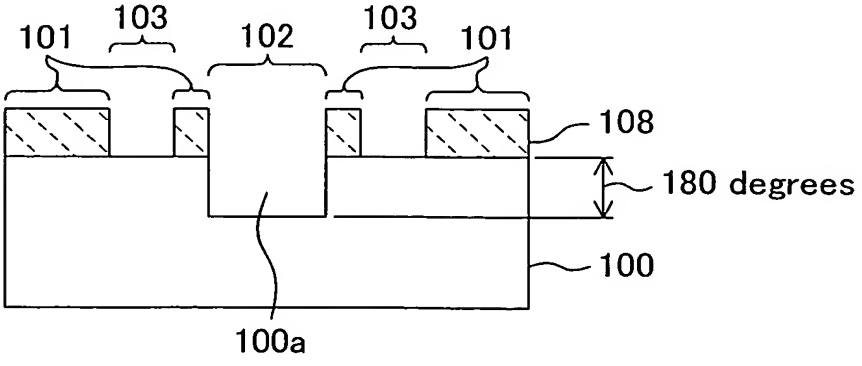


FIG. 7A

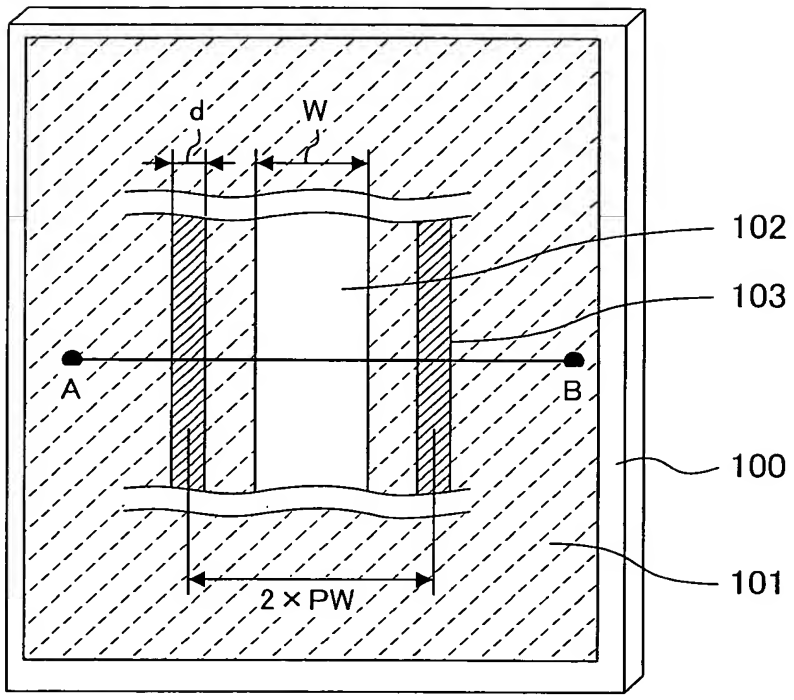


FIG. 7B

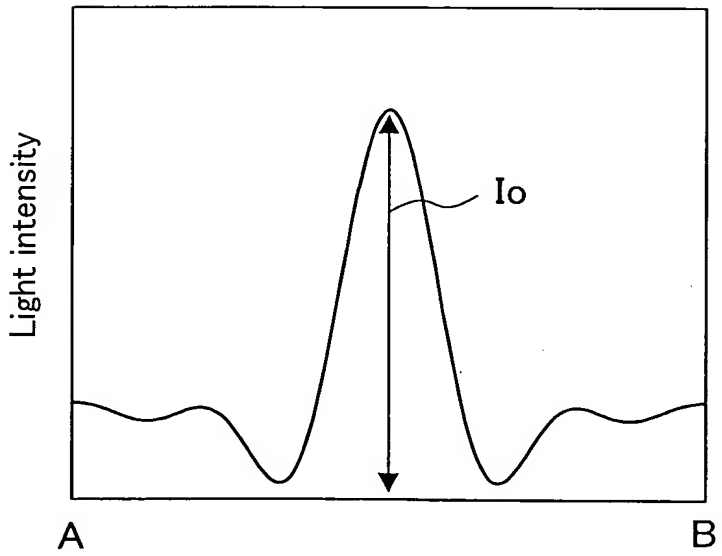


FIG. 8A

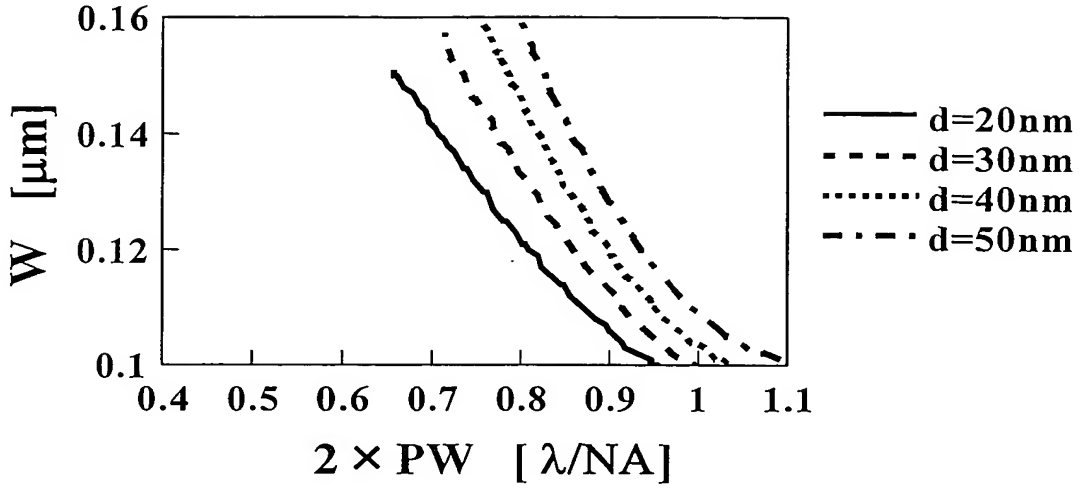


FIG. 8B

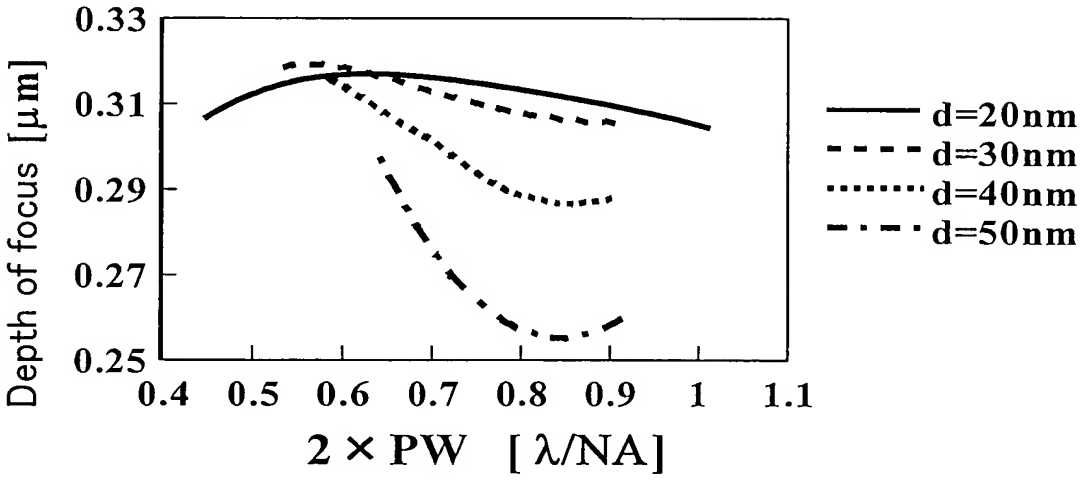


FIG. 8C

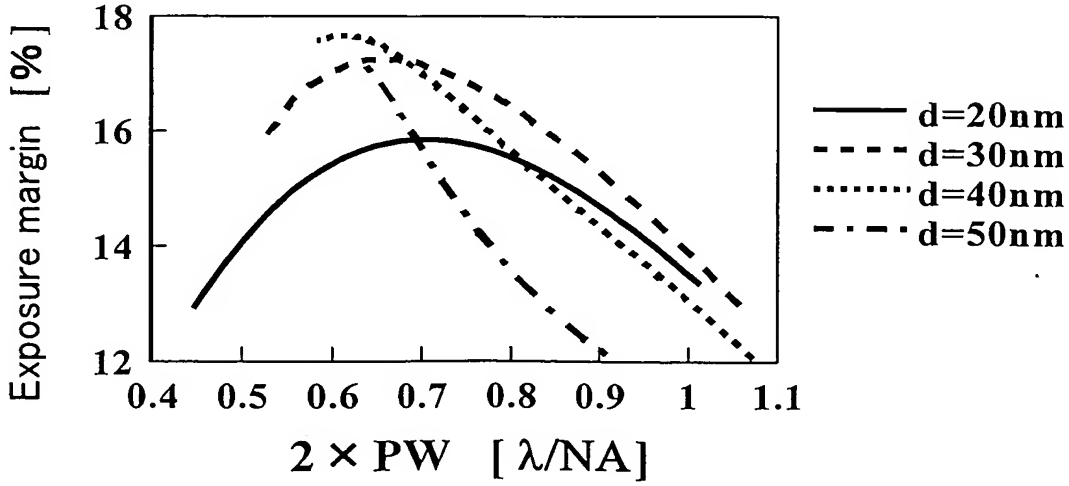


FIG. 9A

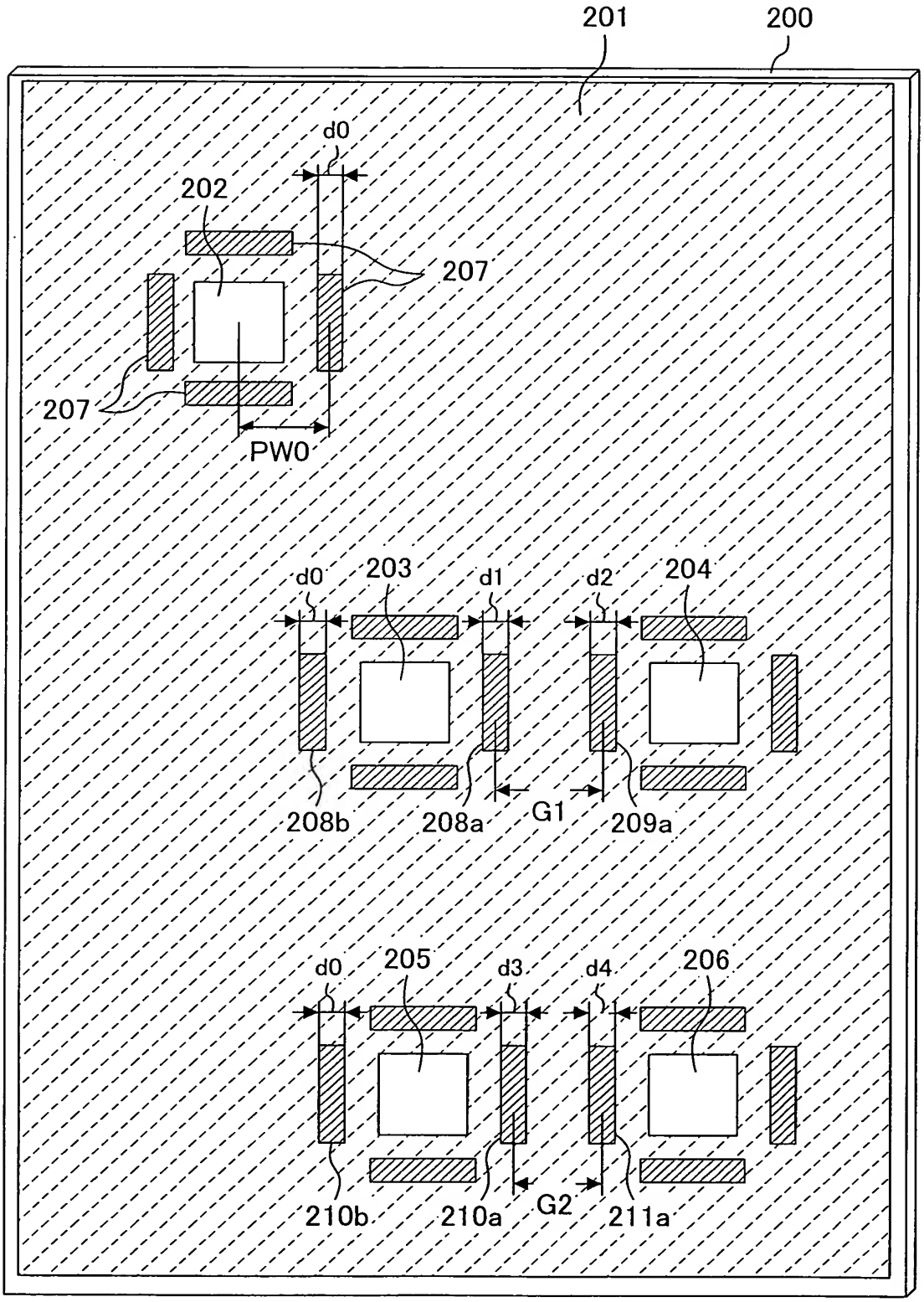

201
200
d0
202
207
207
PW0
d0
203
d1
d2
204
208b
208a
G1
209a
d0
205
d3
d4
206
210b
210a
G2
211a

FIG. 10A

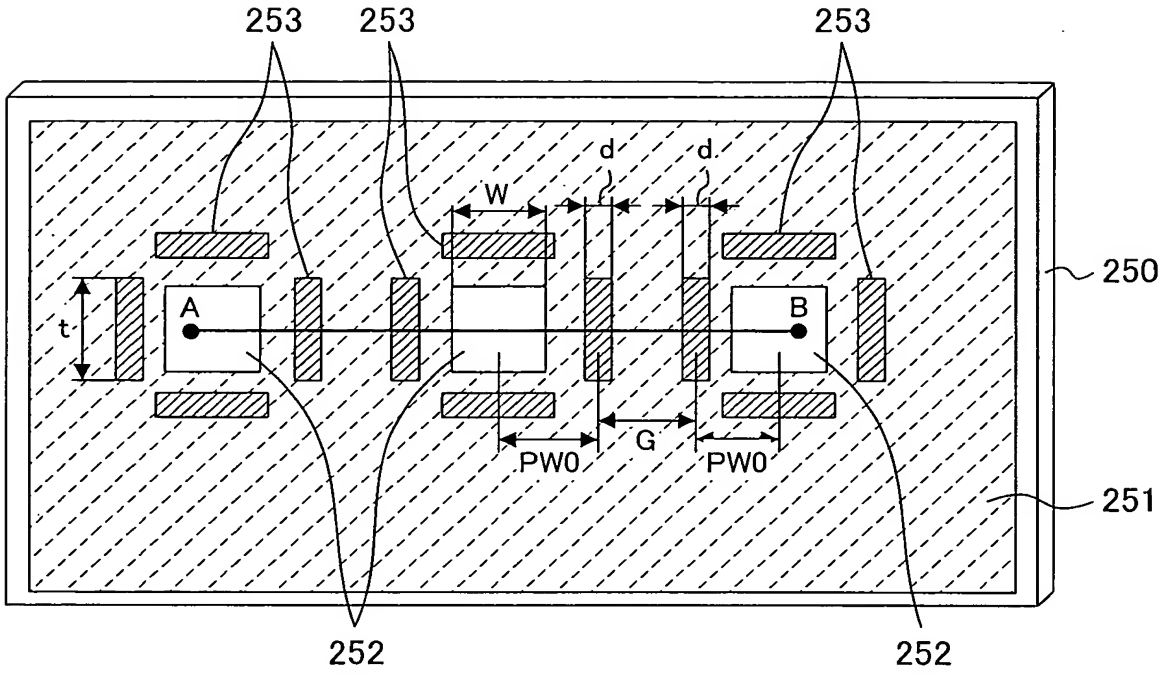


FIG. 10B

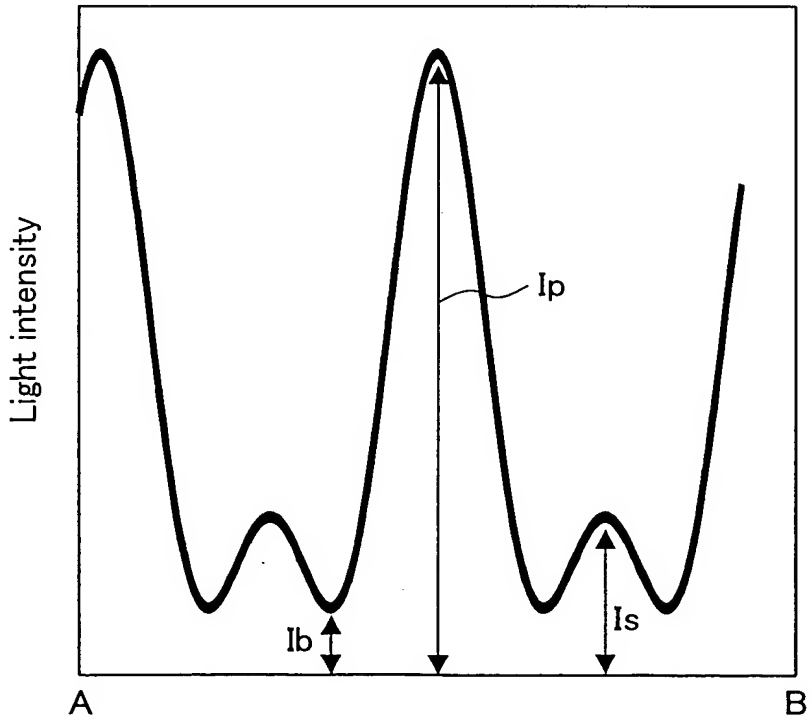
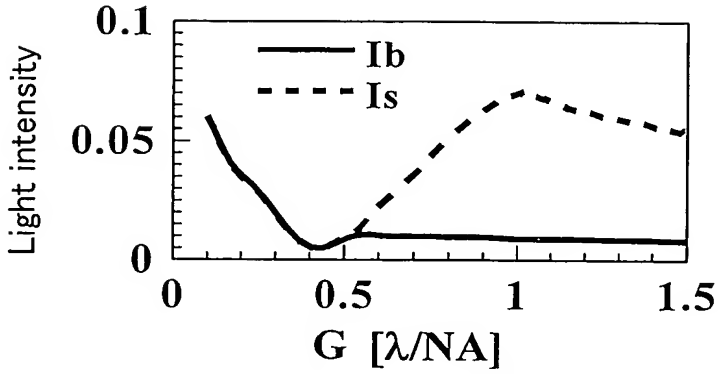


FIG. 11A



Optimization of width of phase shifter	G<0.5 × λ/NA d=d0 × (0.5+G)/(λ/NA)

FIG. 11B

G=0.3 × λ/NA

d=0.8 × d0

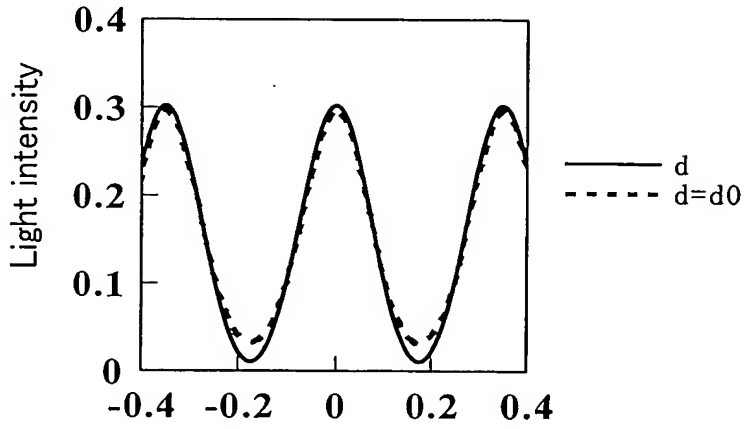


FIG. 11C

G=0.2 × λ/NA

d=0.7 × d0

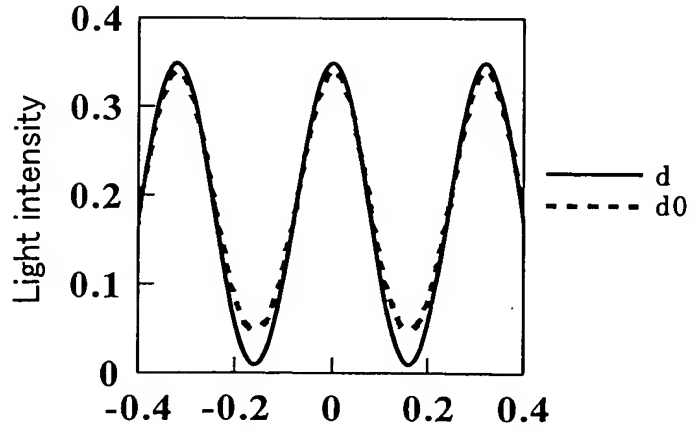
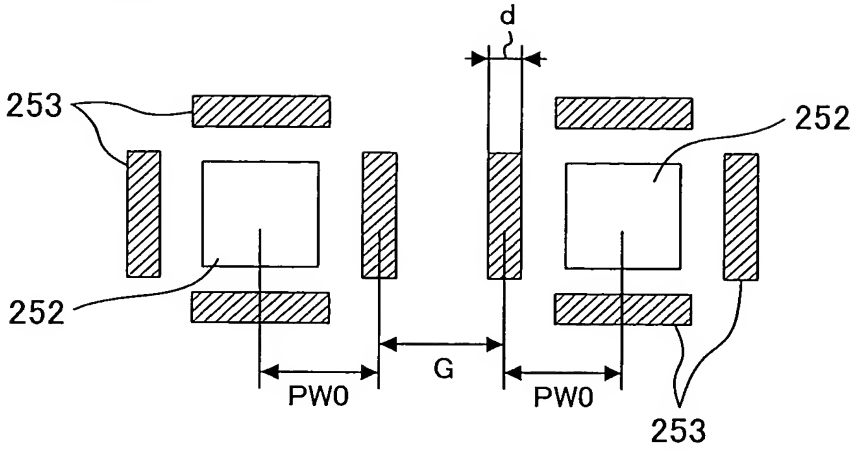
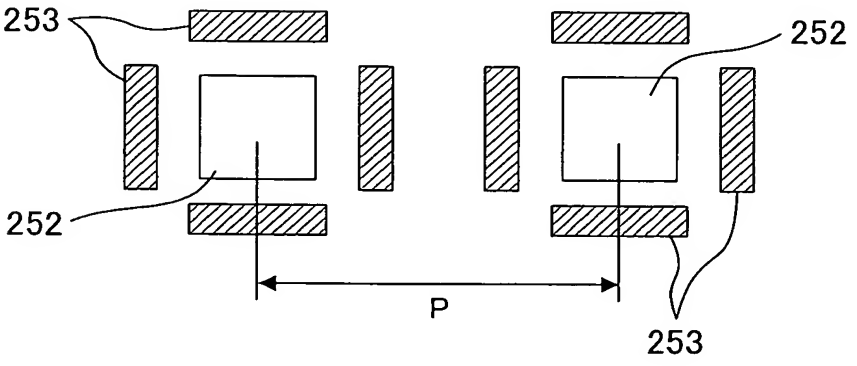


FIG. 12A



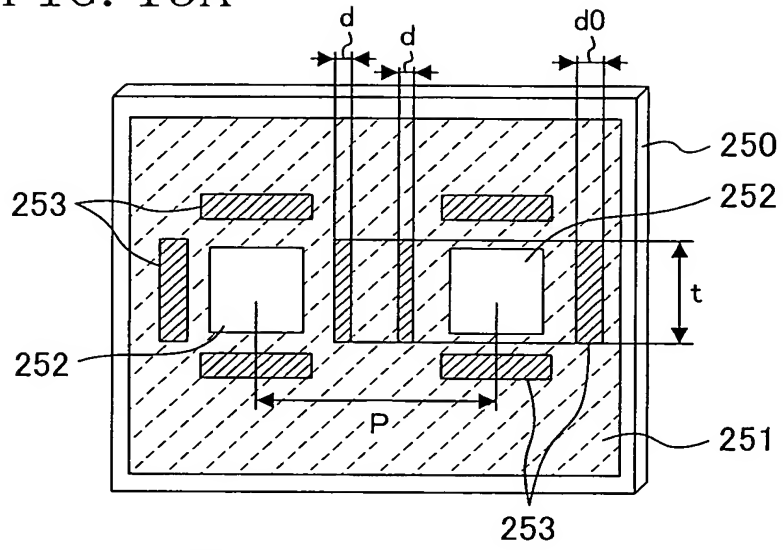
Optimum value of PW0: obtained when 0.4 x λ /NA and G < 0.5 x λ /NA with d set to small value

FIG. 12B



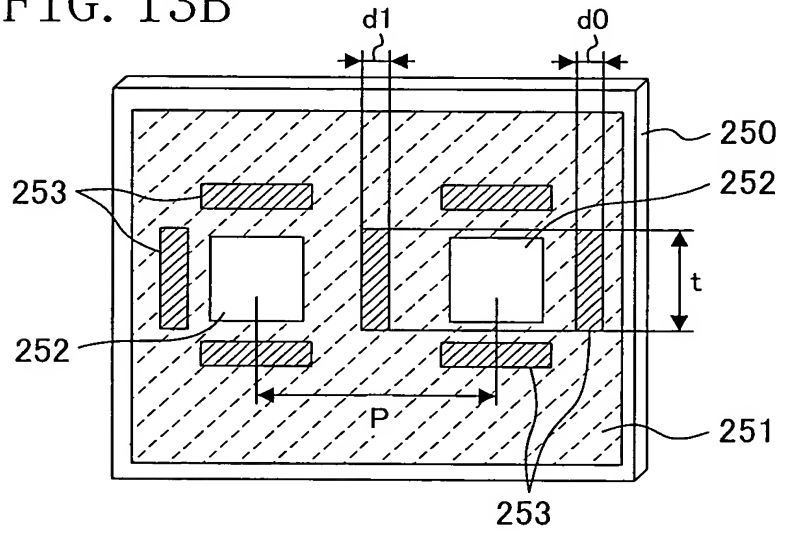
Since P = 2 x PW0 + G, P < 1.3 x λ /NA with d set to small value

FIG. 13A



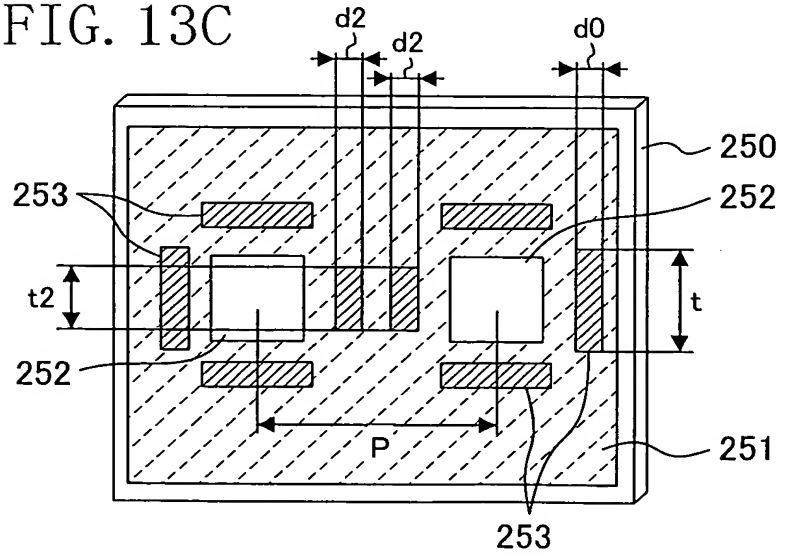
$P<1.3\times\lambda/NA$
$d<d0$

FIG. 13B



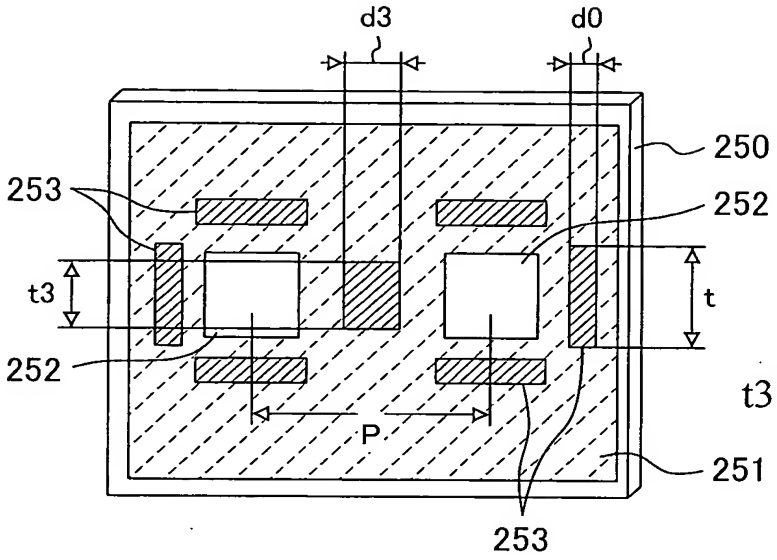
$P<1.3\times\lambda/NA$
$d1<2\times d0$

FIG. 13C



$P<1.3\times\lambda/NA$
$t2\times d2<t\times d0$

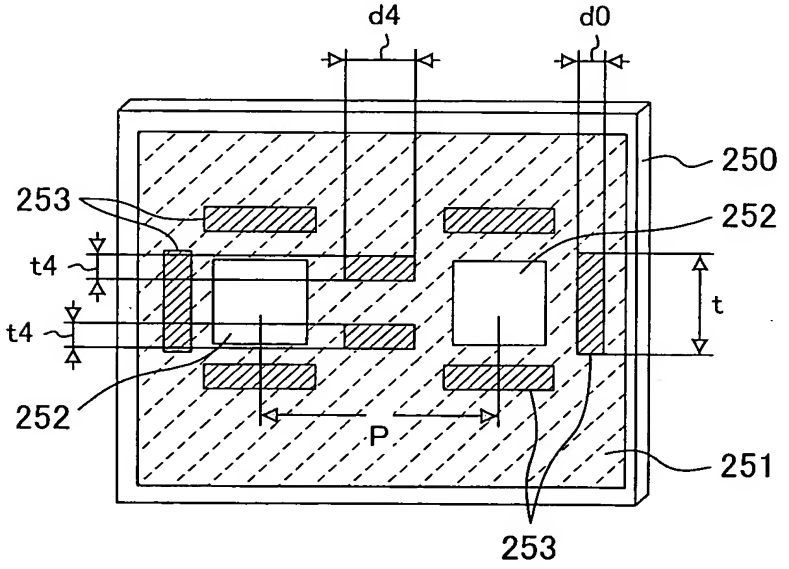
FIG. 14A



$P<1.3\times\lambda/NA$

$t3\times d3<2\times t\times d0$

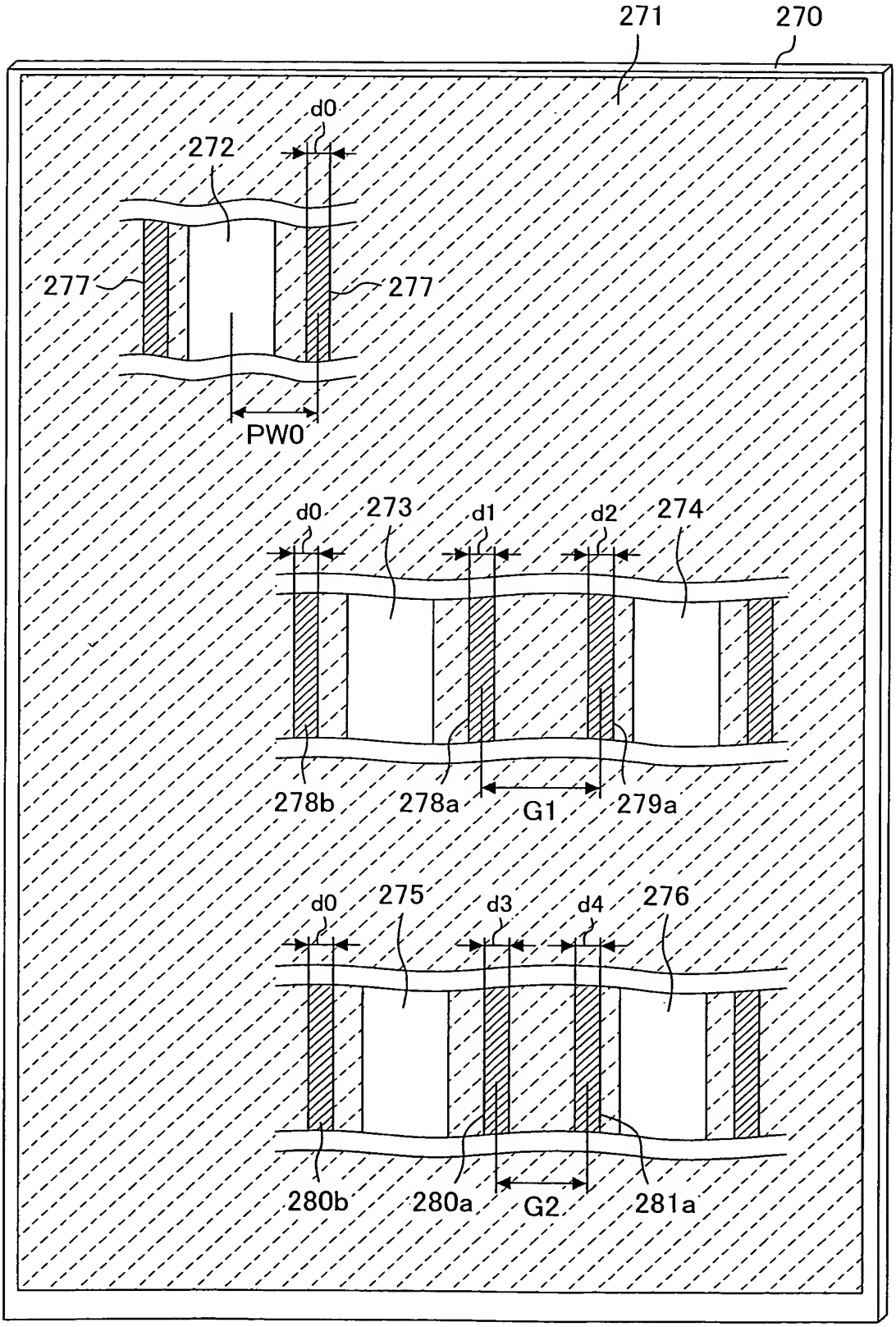
FIG. 14B



$P<1.3\times\lambda/NA$

$t4\times d4<t\times d0$

FIG. 15


271
270
d0
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277
277
PW0
d0
273
d1
d2
274
278b
278a
G1
279a
d0
275
d3
d4
276
280b
280a
G2
281a

FIG. 16A

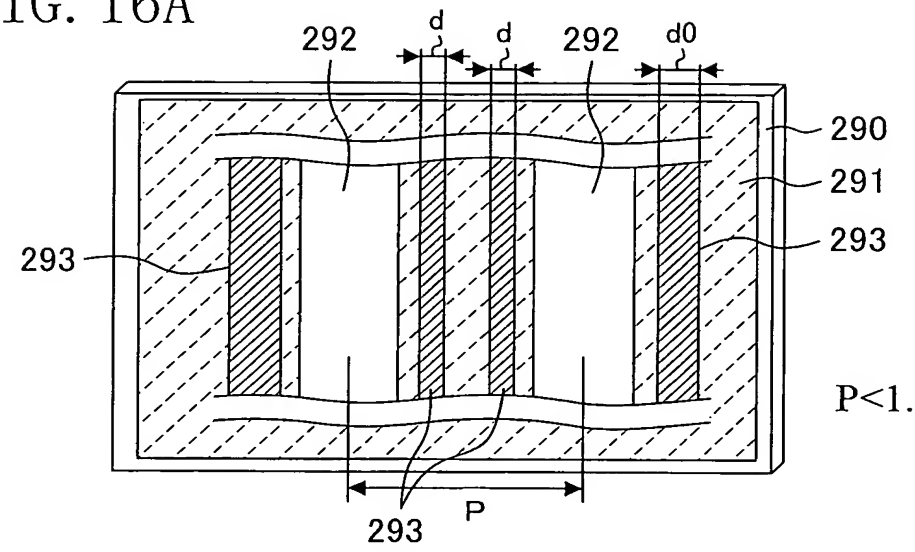


FIG. 16B

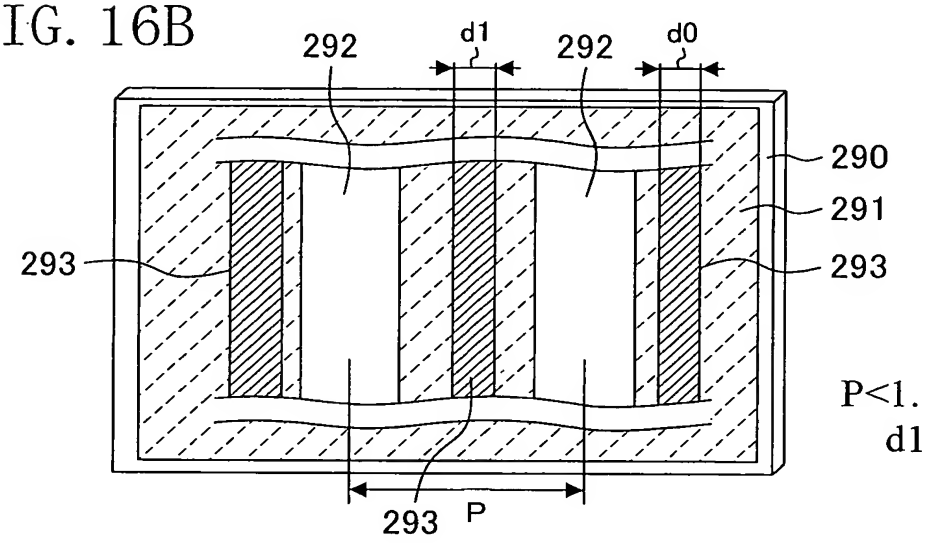


FIG. 16C

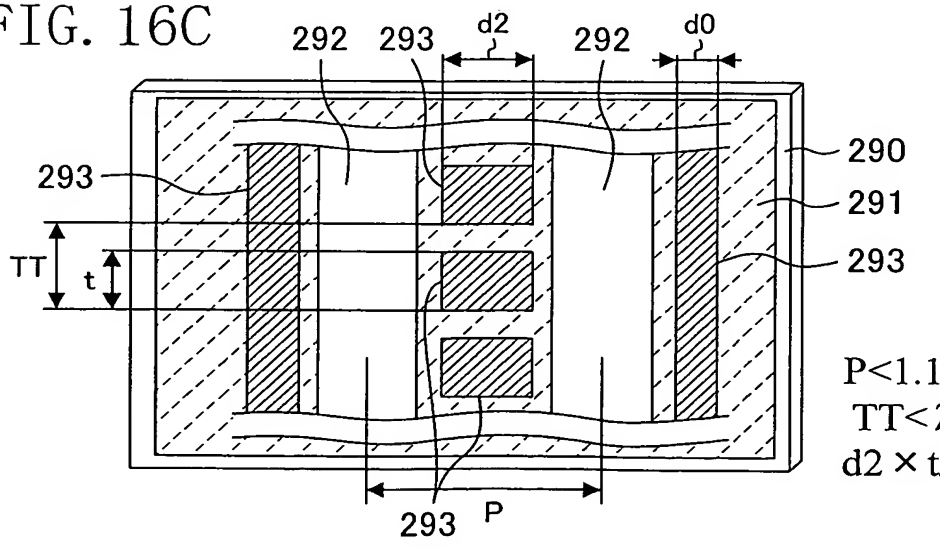
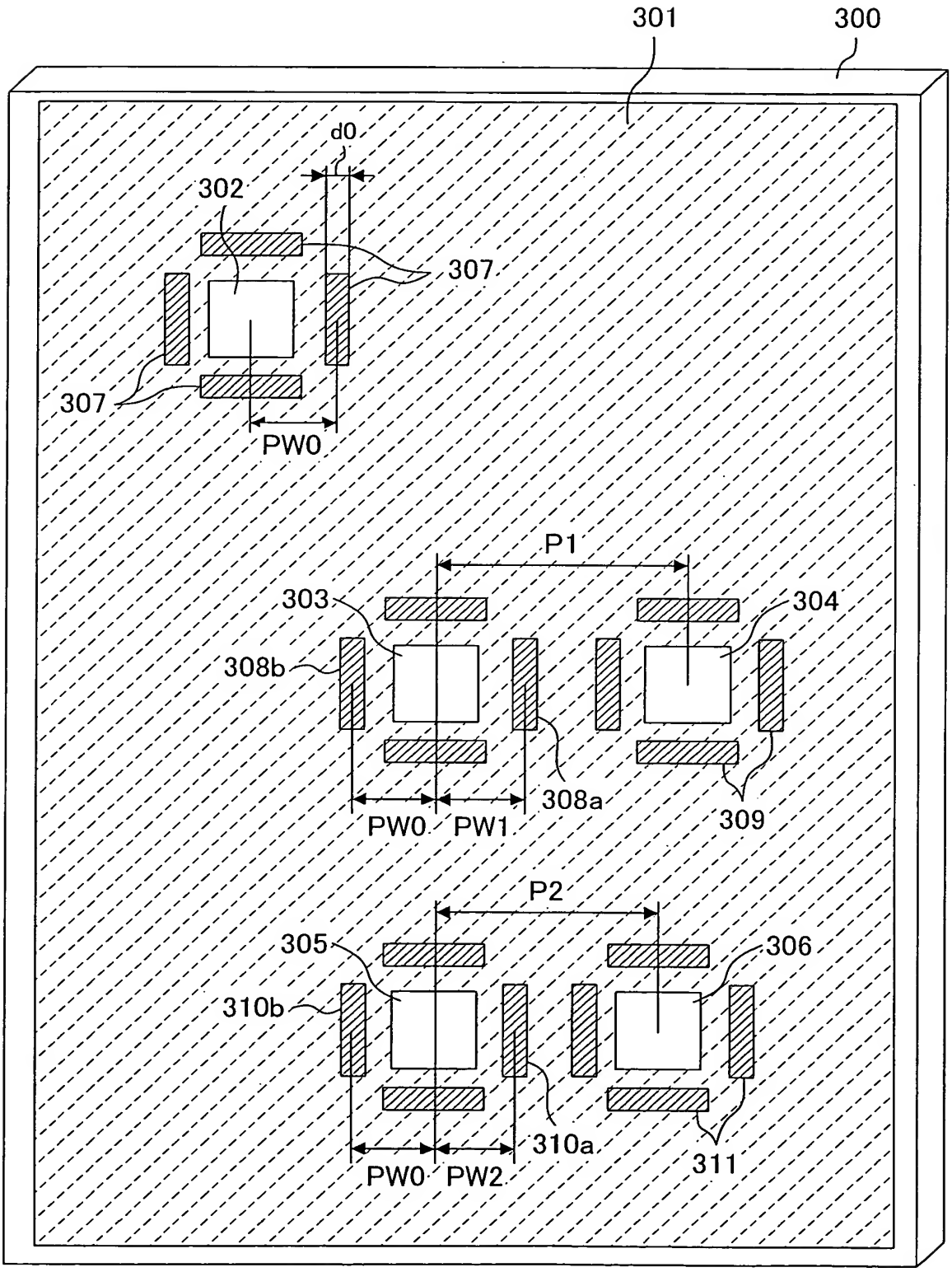


FIG. 17


301
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302
307
307
PW0
P1
303
304
308b
308a
309
PW0
PW1
P2
305
306
310b
310a
311
PW0
PW2

FIG. 18A

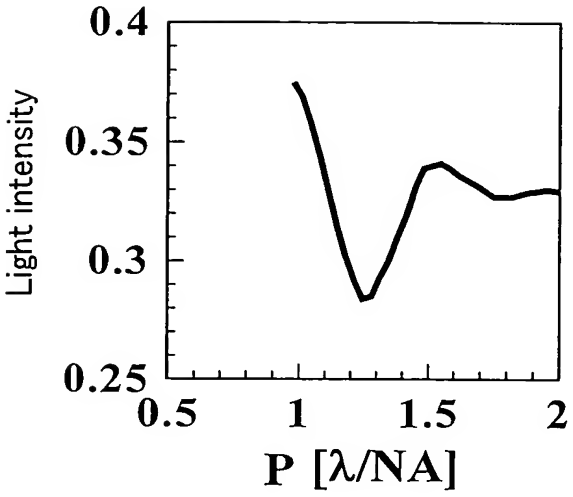


FIG. 18B

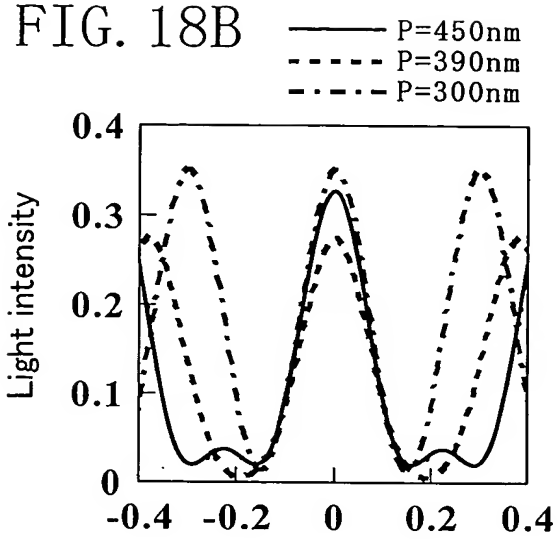


FIG. 18C

$$PW(P)=PW0+\Delta PW(P)\times PW0$$

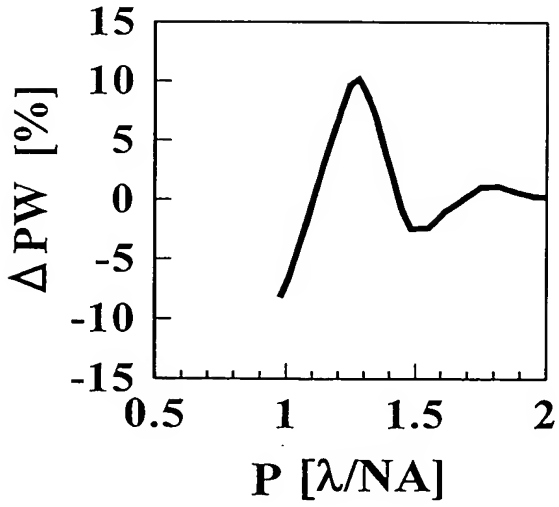


FIG. 18D

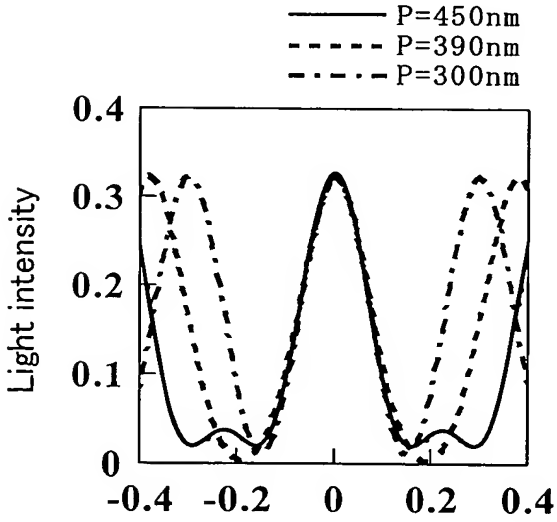
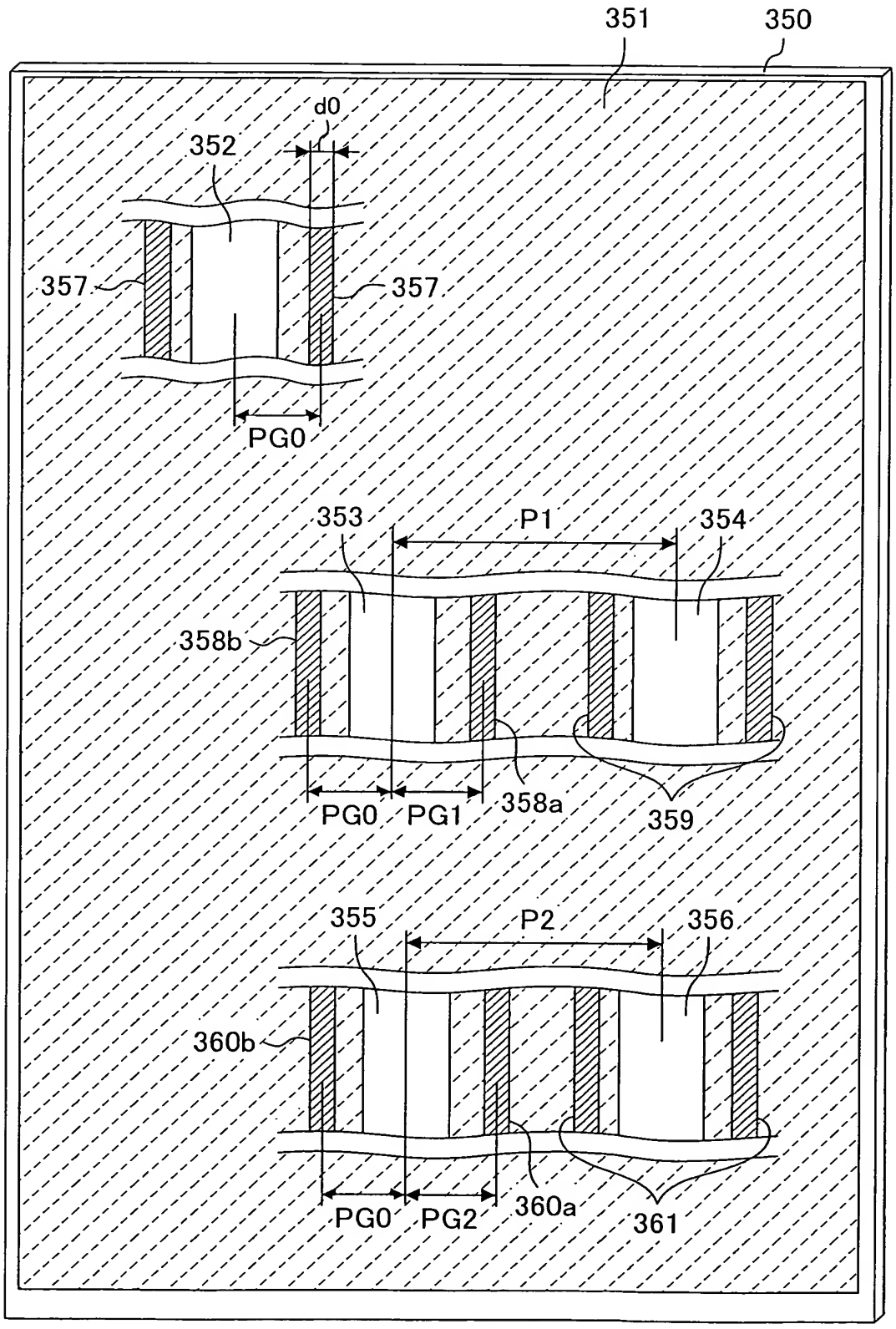


FIG. 19


351
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PG0
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P1
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358b
PG0
PG1
358a
359
355
P2
356
360b
PG0
PG2
360a
361

FIG. 20A

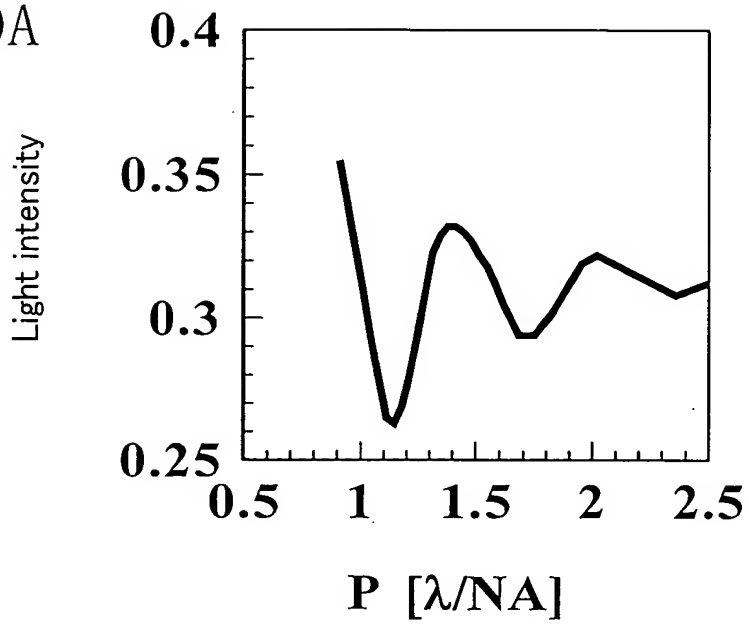


FIG. 20B

$$PW(P)=PW0+\Delta PW(P)\times PW0$$

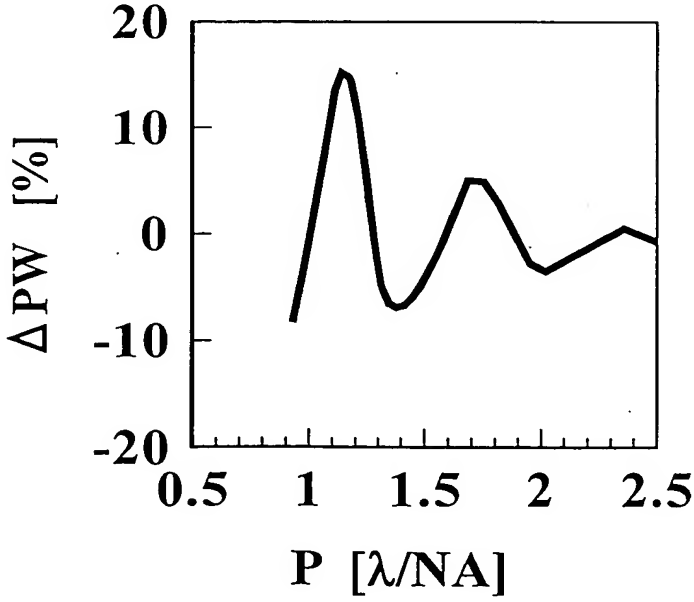


FIG. 21A

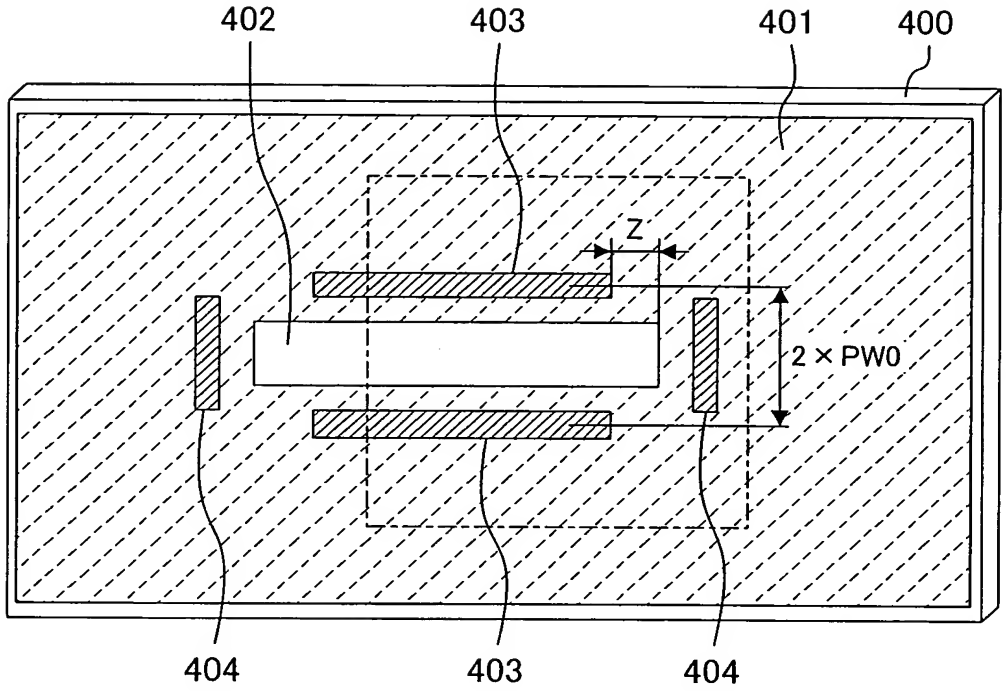


FIG. 21B

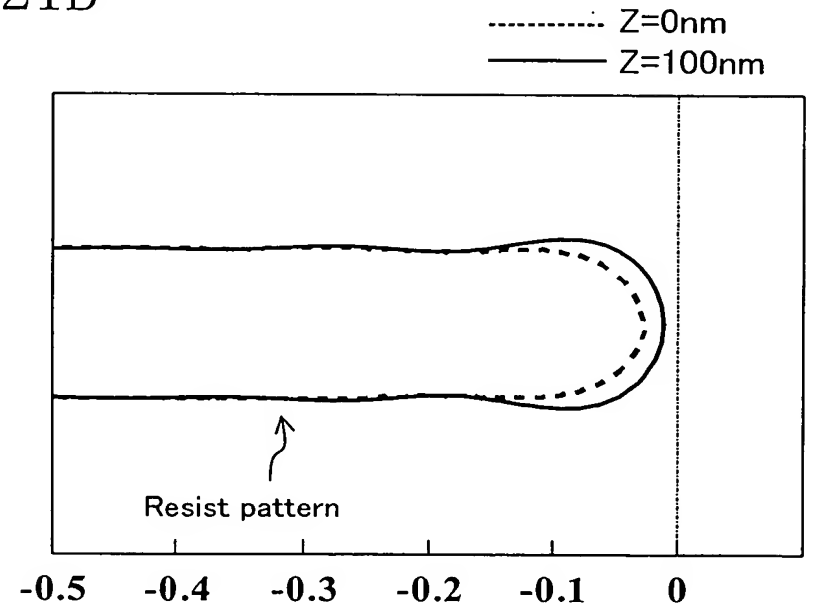


FIG. 22A

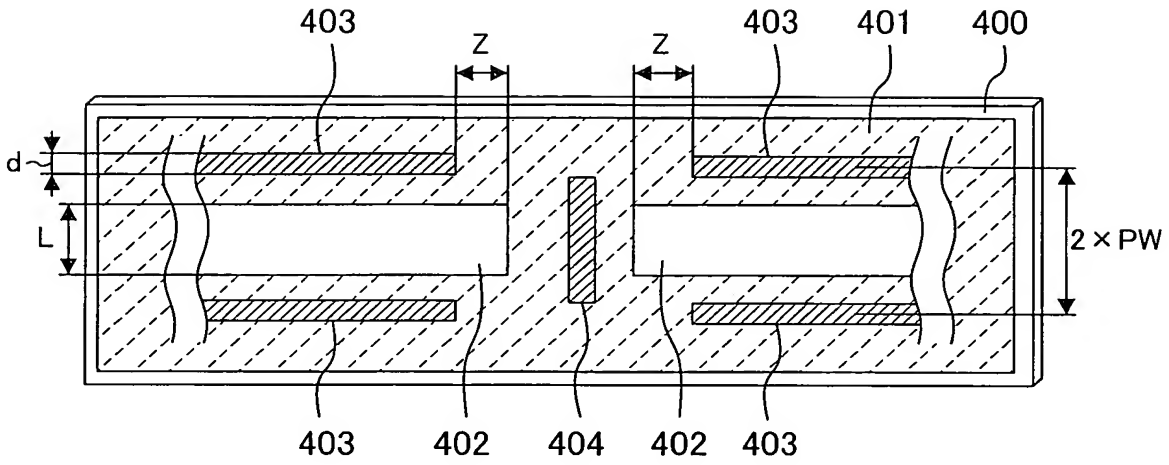


FIG. 22B

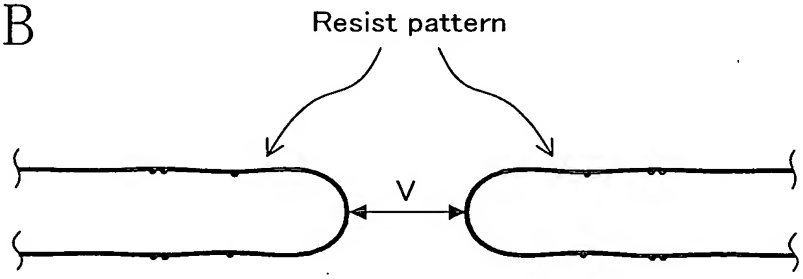


FIG. 22C

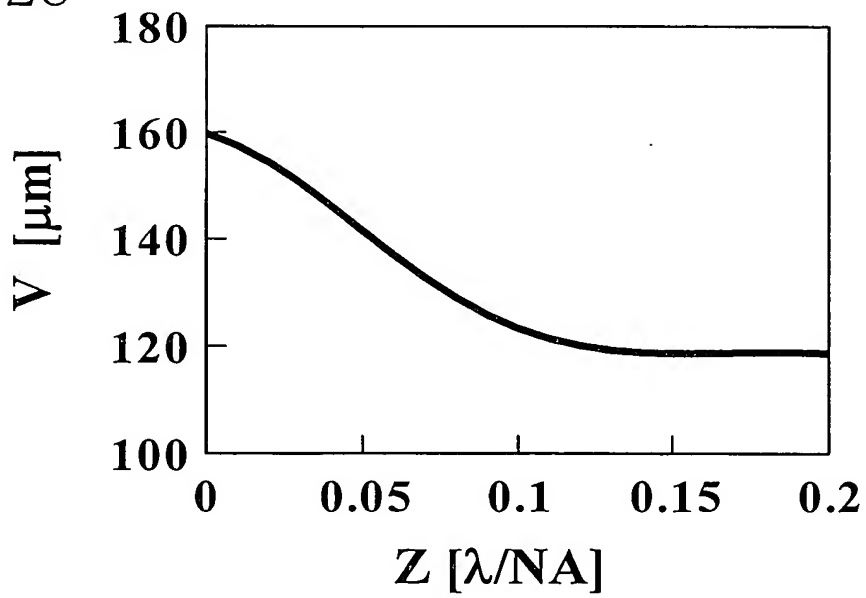


FIG. 23A

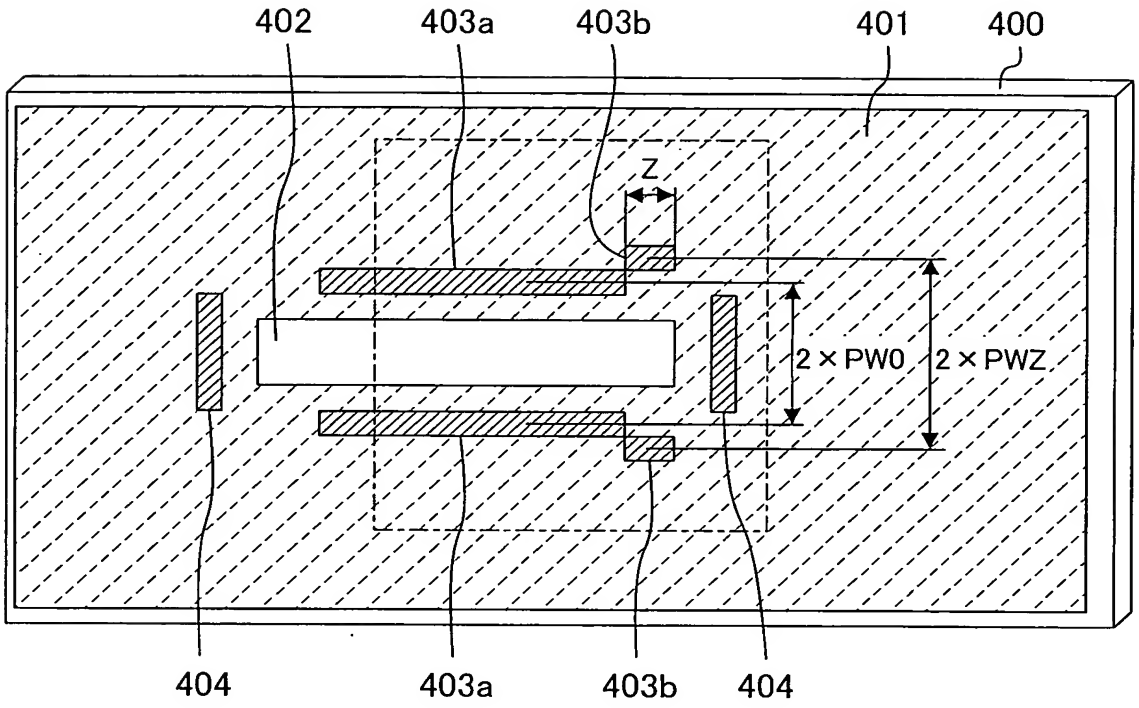


FIG. 23B

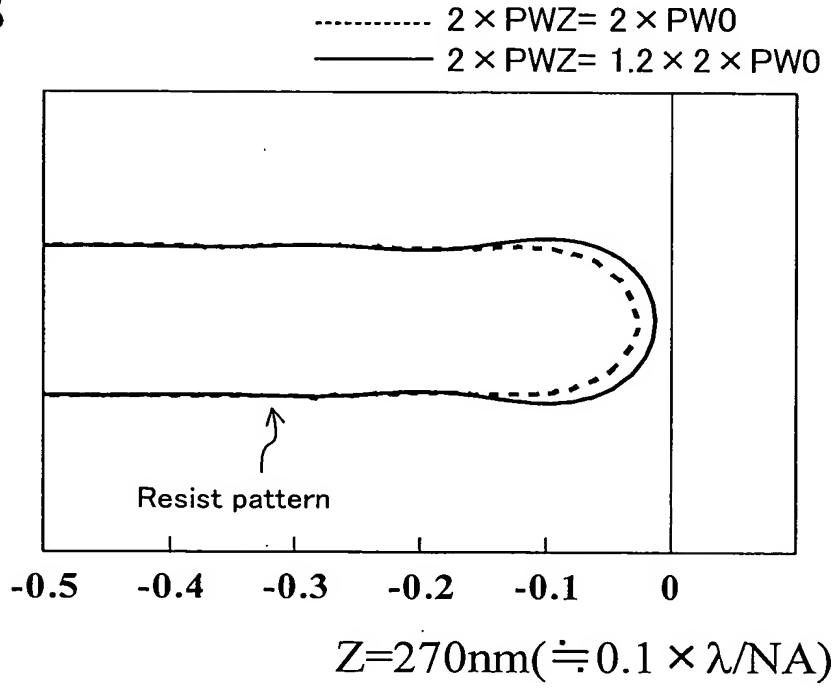


FIG. 24A

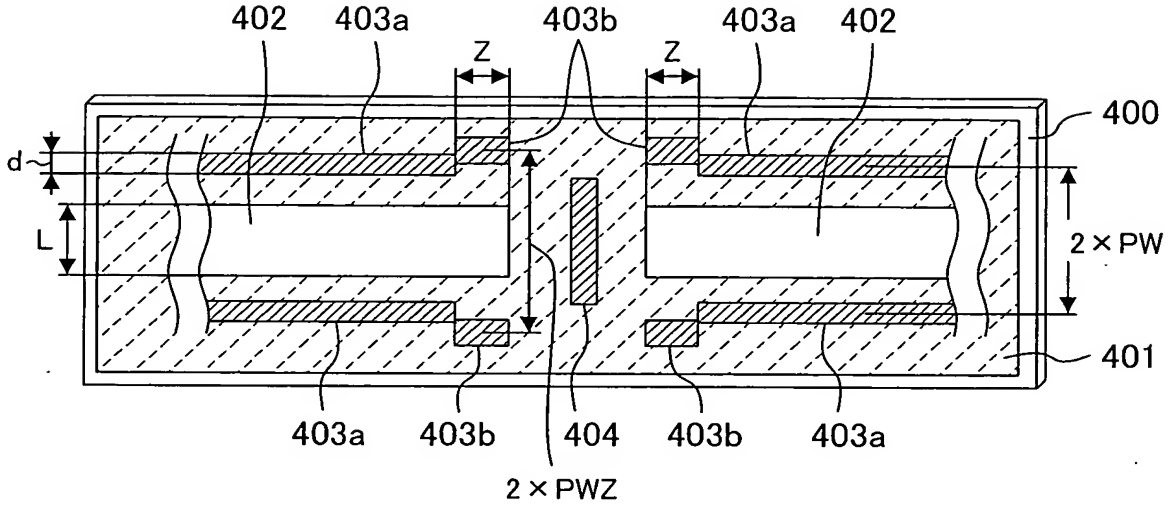


FIG. 24B

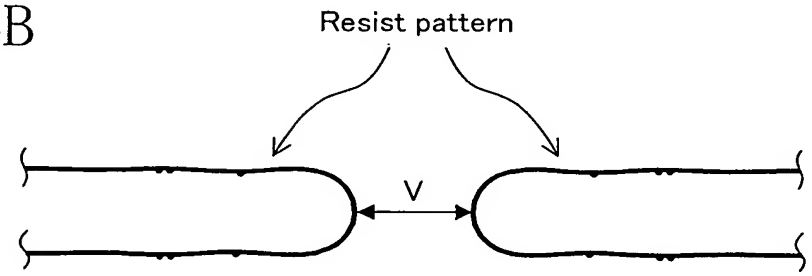


FIG. 24C

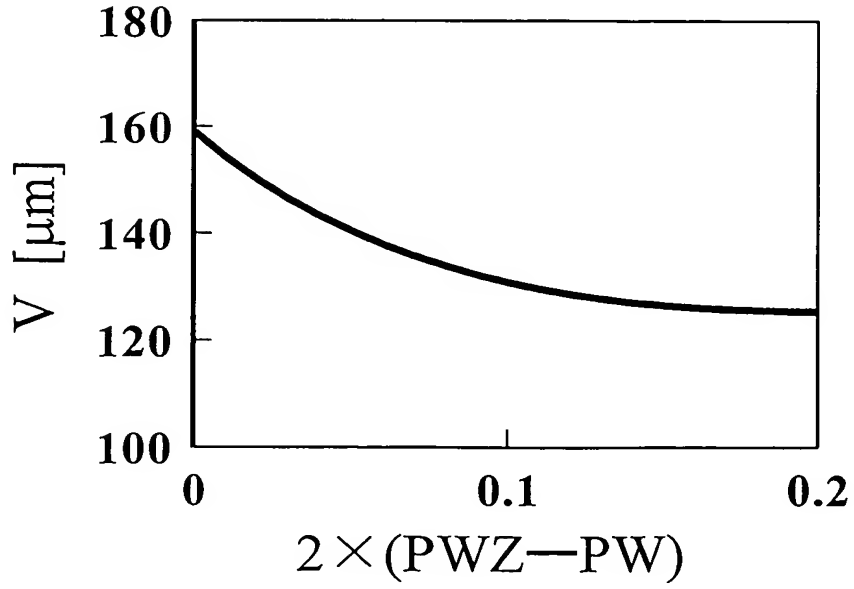


FIG. 25A

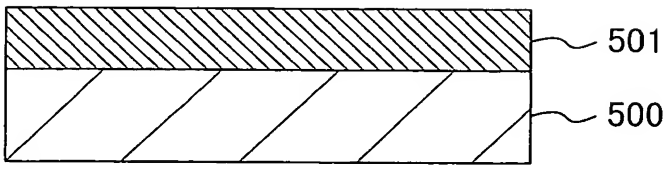


FIG. 25B

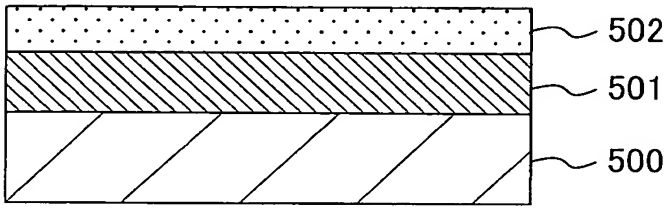


FIG. 25C

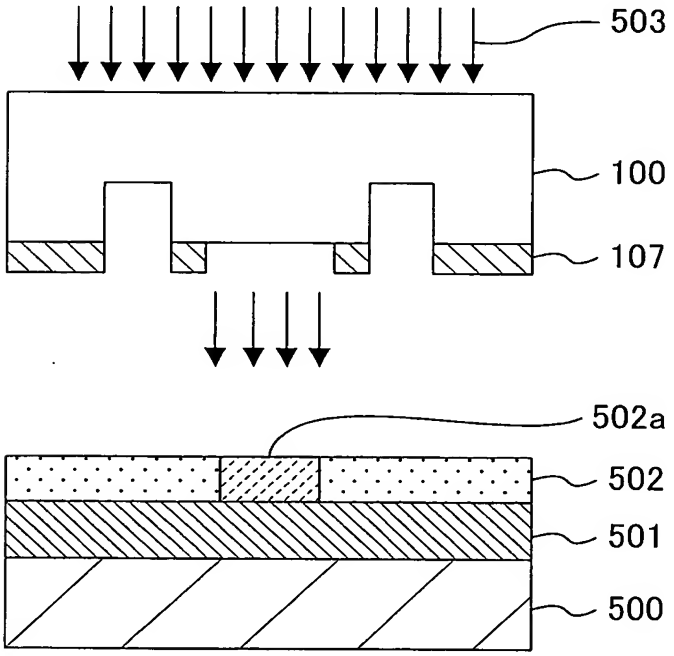


FIG. 25D

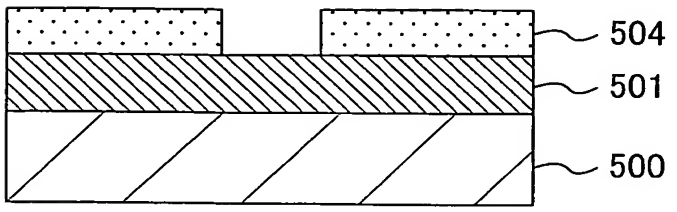
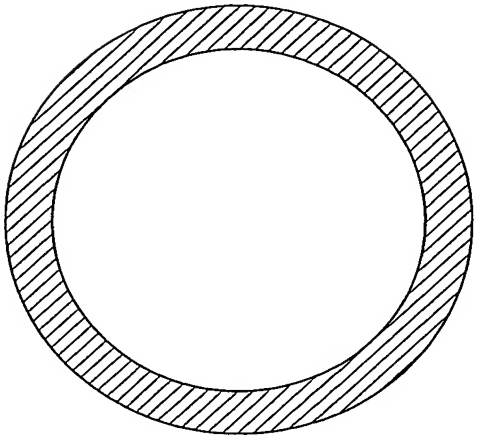
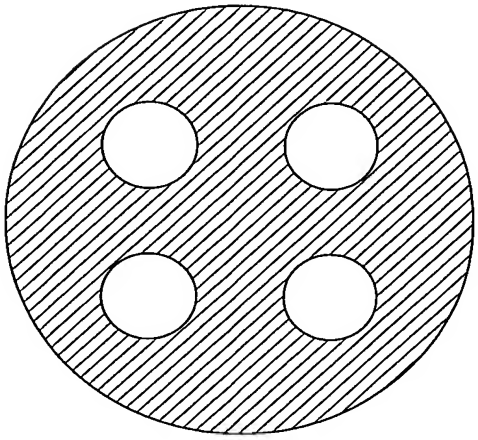


FIG. 26A



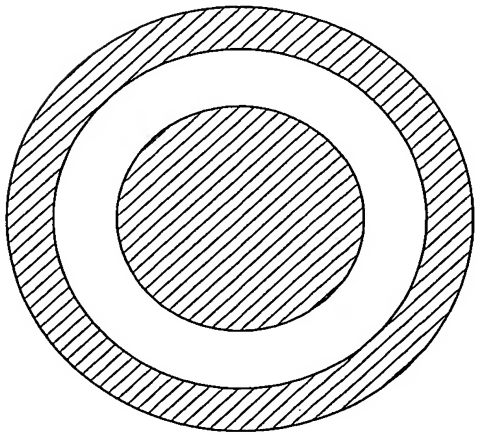
[General exposure light source]

FIG. 26C



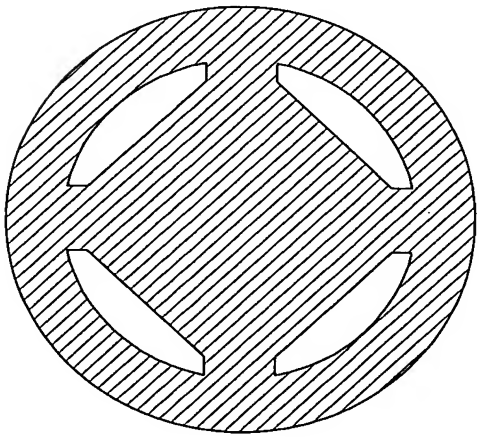
[Quadrupole exposure light source]

FIG. 26B



[Annular exposure light source]

FIG. 26D



[Annular/quadrupole exposure light source]

FIG. 27A

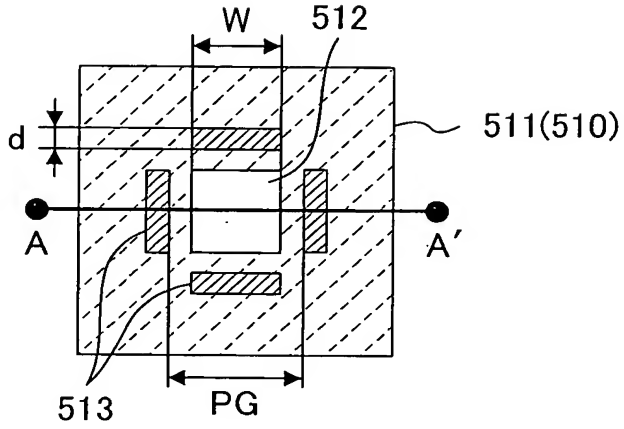


FIG. 27B

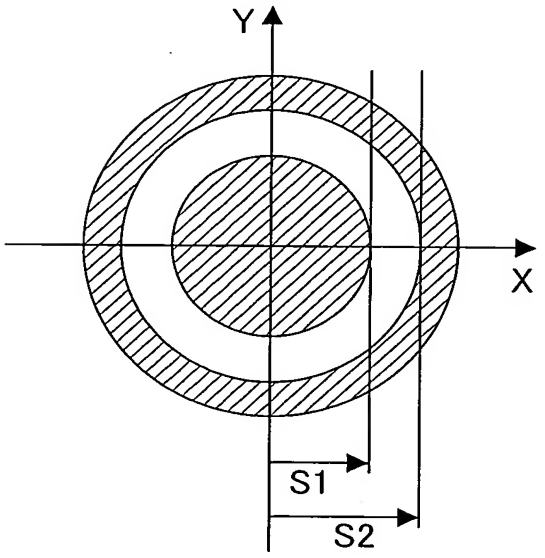


FIG. 27C

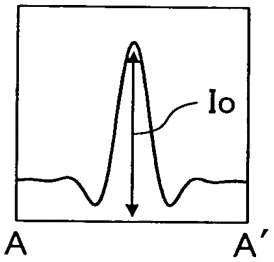


FIG. 27D

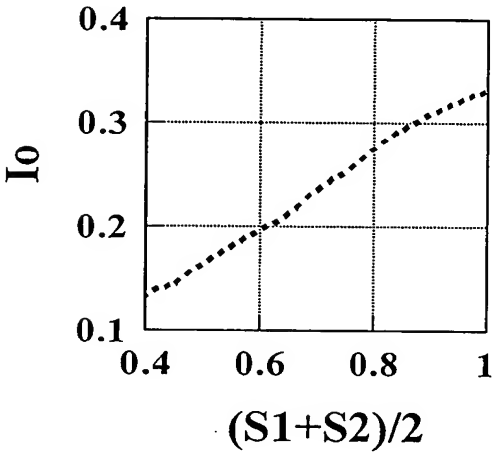


FIG. 27E

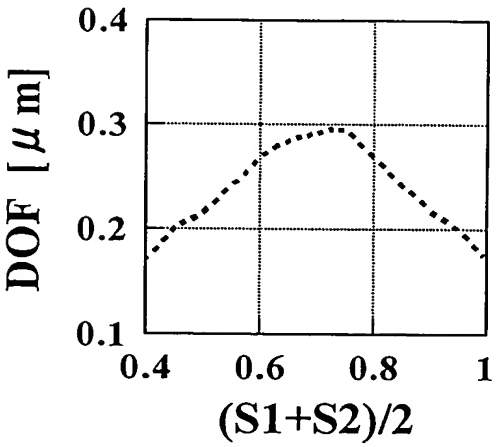


FIG. 28

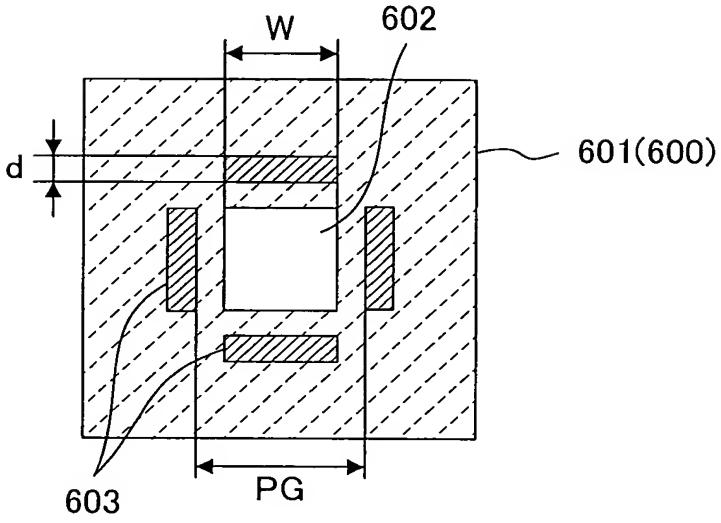


FIG. 29

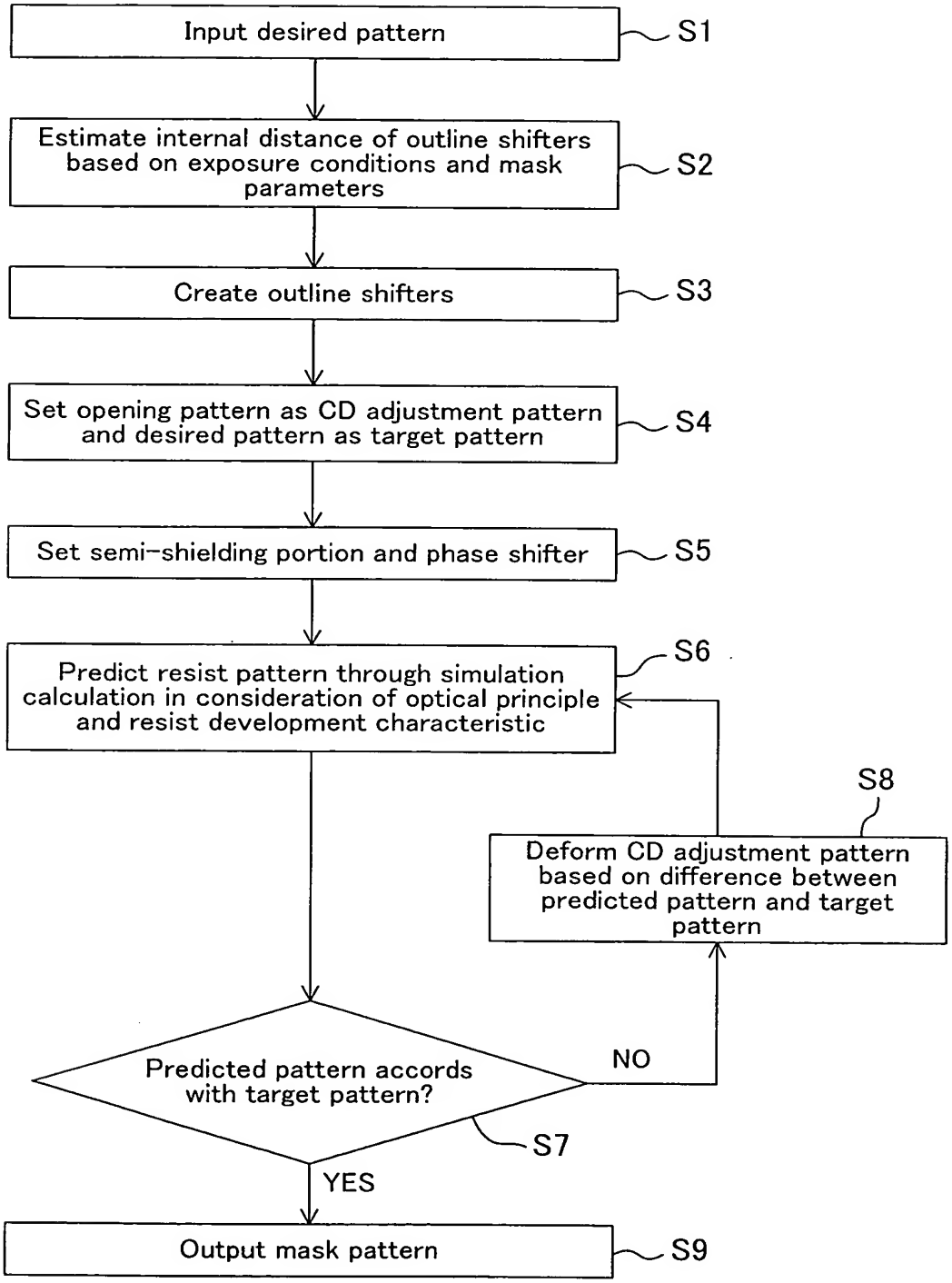

Input desired pattern
S1
Estimate internal distance of outline shifters based on exposure conditions and mask parameters
S2
Create outline shifters
S3
Set opening pattern as CD adjustment pattern and desired pattern as target pattern
S4
Set semi-shielding portion and phase shifter
S5
Predict resist pattern through simulation calculation in consideration of optical principle and resist development characteristic
S6
S8
Deform CD adjustment pattern based on difference between predicted pattern and target pattern
Predicted pattern accords with target pattern?
NO
S7
YES
Output mask pattern
S9

FIG. 30A

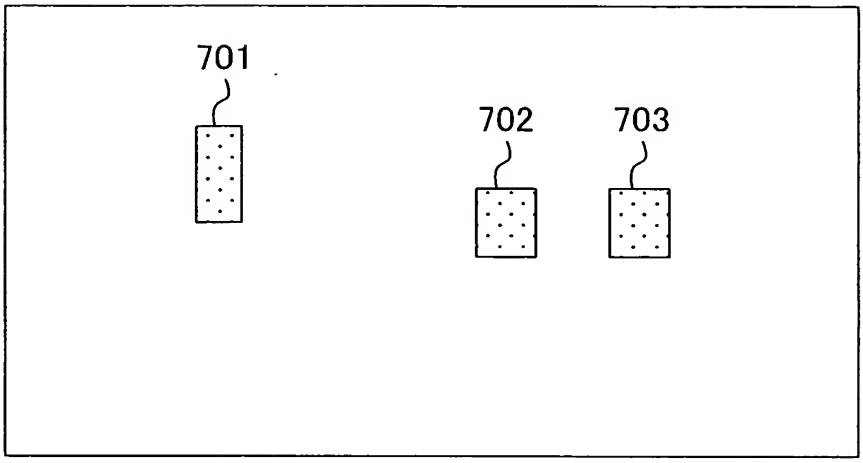


FIG. 30B

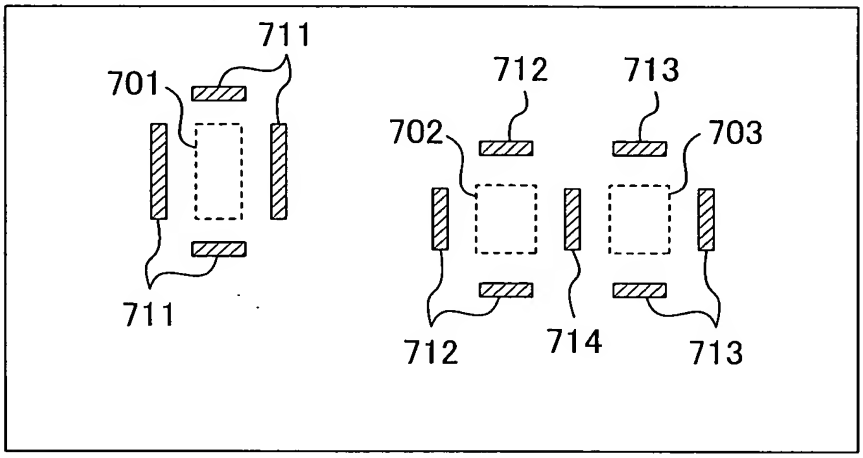


FIG. 30C

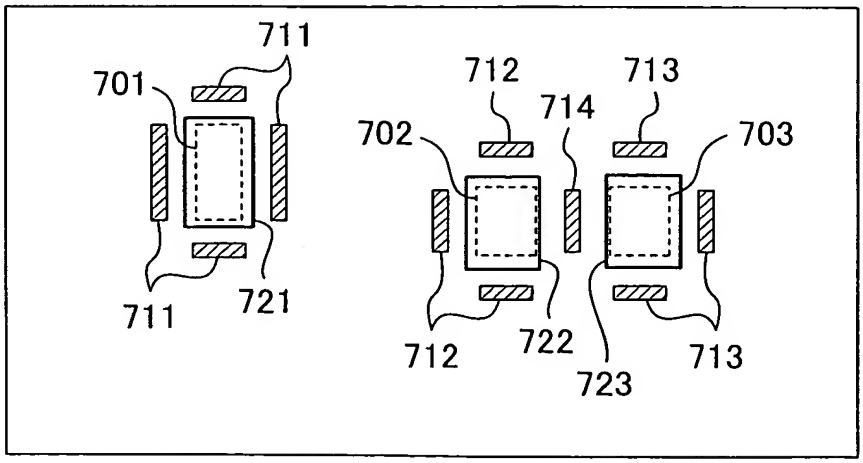


FIG. 31A

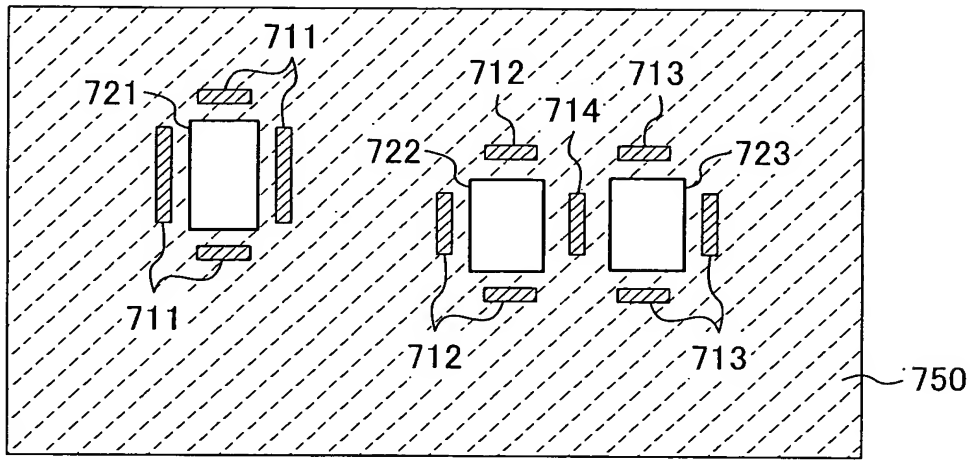


FIG. 31B

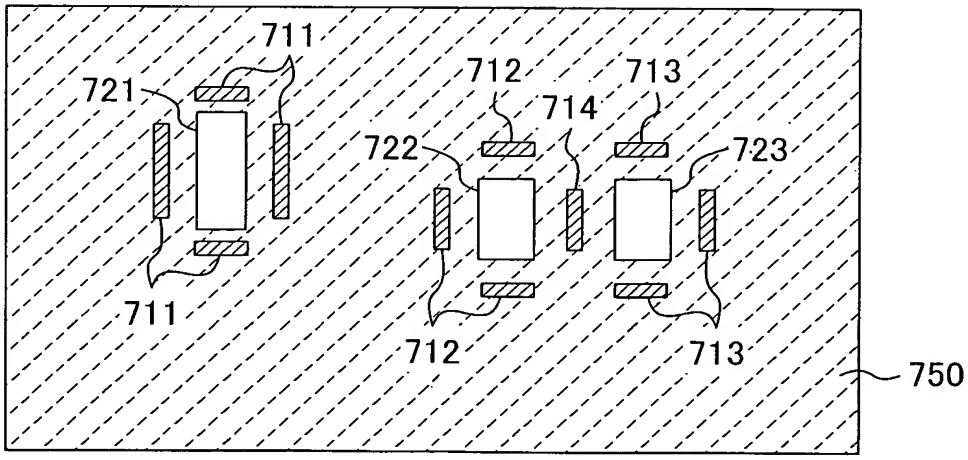


FIG. 32A
PRIOR ART

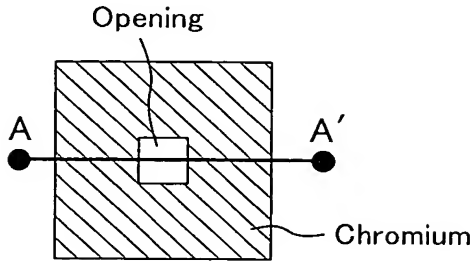


FIG. 32B
PRIOR ART

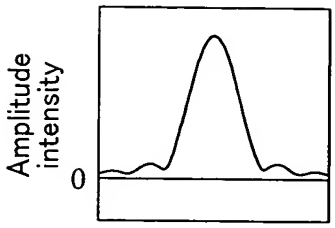


FIG. 32C
PRIOR ART

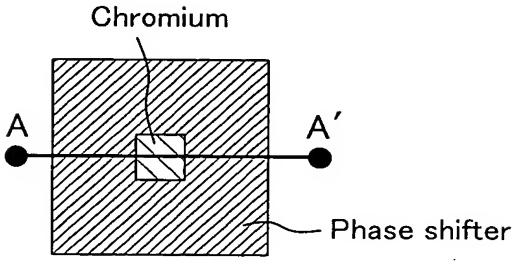


FIG. 32D
PRIOR ART

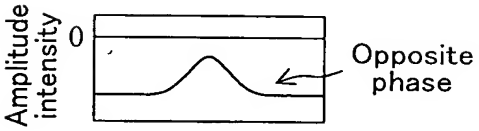


FIG. 32E
PRIOR ART

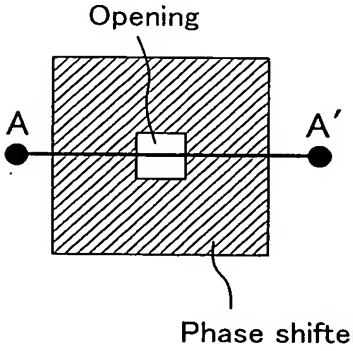


FIG. 32F
PRIOR ART

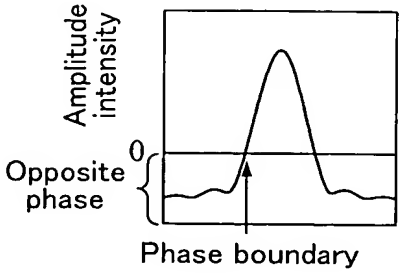


FIG. 32G
PRIOR ART